Industry and Power

May 1955

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A thermodynamics refresher for you starts with basic concepts . . . . . p 59

Hi-freq power is versatile — p 35

"No trouble holding vacuum with these traps"

"They certainly are an easy trap to maintain. We haven't done a thing to them yet—and no more trouble holding vacuum", says Joseph Vermuelen, Floral Avenue Greenhouses, Mt. Clemens, Mich.

Dozens of Armstrong "blast" traps are used at this greenhouse to drain heating coils operating at 2 to 10 lbs. pressure with a 10" vacuum return.

Armstrong traps are especially desirable for low pressure vacuum return systems because of their durability and long service without leakage. (It's the leaky traps that make you lose vacuum.)

There is nothing in an Armstrong trap to rupture. The bucket is open. Every trap is factory tested at 500 lbs. water pressure. Hardened chrome steel valve and seat ... stainless steel bucket and lever assembly—the same design, materials and workmanship used in Armstrong traps for power plant service at 900 lbs. pressure, 900 degrees temperature! It's no wonder they last for years without repairs in low pressure vacuum return service. Don't ever let anyone tell you the Armstrong inverted bucket trap isn't good for this service. It's best! There's proof galore. Ask your Armstrong Representative for the facts, or write:

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820 Maple Street, Three Rivers, Michigan

Application Engineered

ARMSTRONG STEAM TRAPS

FREE FACTS FOR YOU . . . Ask for these reprints: "Vacuum isn't Vacuum to a Steam Trap" and "Flash at Traps". Here are facts to give you better trapping. Write or call today, no obligation.

535

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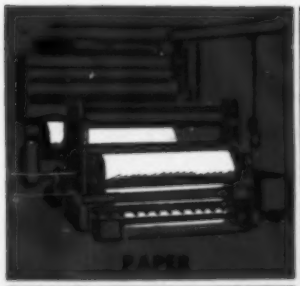

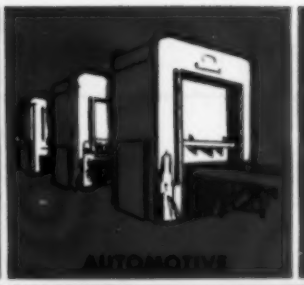

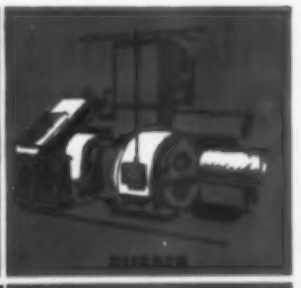

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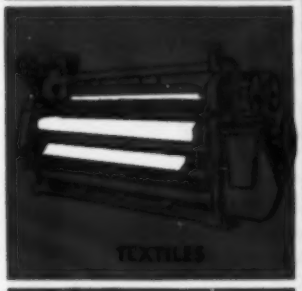

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this month's comment

. . . from industry & power

to the men responsible for industry's power services . . .

On this 35th Anniversary of the founding of our magazine, it is with great pleasure that we announce the transfer of ownership of INDUSTRY & POWER to The John Paul Taylor Publishing Co.

In May, 1920, A. R. Maujer with fine leadership and foresight brought out the first issue of INDUSTRY & POWER. I well remember the 20th Anniversary. In May, 1940, I had been with the magazine for nearly one year and, as assistant editor, helped produce the 20th Anniversary Issue—an issue that expressed the forward-looking attitude that always had been characteristic of the magazine. That issue was devoted to the future of engineering achievements—predictions of energy use, of developments in power services for industry.

INDUSTRY & POWER has continued to serve its readers through the years with a fine tradition of supplying the best articles, stories, and news available in this field. We intend to continue this tradition and to add to it. In the words of our *Credo:*

INDUSTRY & POWER will continue to serve the technical and professional interests of the men responsible for

INDUSTRY'S POWER SERVICES

STEAM—generating, distributing, utilizing
ELECTRICITY—generating, distributing, utilizing
GASES—compressing, cleaning, heating, cooling, distributing
LIQUIDS—treating, heating, cooling, distributing
FUELS—storing, transporting, consuming
WASTES—treating, disposing
MECHANICAL POWER—producing, transmitting, utilizing

Our editorial policy is aimed at directly and completely covering these power services. The pages of this magazine will tell you about the men who do things as well as what they do. We shall continue to give you usable, thought-provoking, up-to-date information and news about Industry's Power Services. We shall endeavor to inspire even greater participation by you, our readers, in INDUSTRY & POWER.

As we take over the job of editing and publishing INDUSTRY & POWER, we want you to know that we will welcome your comments at any time.

John Paul Taylor
Editor and Publisher

The John Paul Taylor Publishing Co.
Commercial Bank Building, St. Joseph, Michigan

Industry and Power

Volume 68 **May 1955** Number 5

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Established May 1920

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Speeds Assembly ...Prevents Rejects

- **Turns and torques both screws and nuts**
- **Releases *automatically* at preset torque limit**
- **Measures accurately in 4 to 80 inch-ounce range**

With PROTO's new Torque Driver—No. 6080—you can speed production work and still maintain accurate low torque on precision assemblies. As fast as a screw, nut or bolt can be tightened, it can be accurately torqued with the Torque Driver. It is especially suited for high-speed precision assembly work in the electronics, communications, aircraft and similar industries. With the many standard attachments on the market, the driver adapts quickly to handle all types of assembly-torquing jobs.

Using the same torque-*limiting* principle as the PROTO torquer, the driver releases automatically. It is impossible to overtorque. There are no dials, pointers or scales to watch—no projecting gadgets. Buy this money-saving new tool from your PROTO dealer today. Send 10¢ for 68-page catalog of entire PROTO line to

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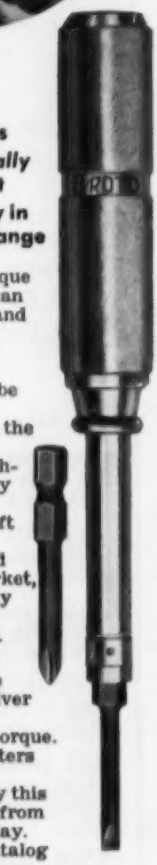

PROTO TOOLS
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Eastern Factory, Jamestown, N.Y. • Canadian Factory, London, Ont.

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nuclear news

. . . . about industry & power

NEW POWER EQUIPMENT is steadily evolving out of the efforts of manufacturers to get themselves established in the nuclear field. This jockeying for position is taking the form of new equipment that simply outperforms previous models. For example, filters have been developed to clean air entering and leaving atomic laboratories so that radioactive particles do not endanger people. The requirements were stiff. The air cleaning device had to trap particles so small that it would take 10,000 of them to equal the thickness of a human hair.

VALVES, TOO, are being steadily improved under the pressure of nuclear application requirements. Leakage rates of one cubic centimeter per 100 million years are the type of performance being studied . . . And just a few weeks ago, representatives of some 14 firms met in all-day session with the Atomic Energy Commission to discuss regulations pertinent to the power equipment industry . . . All in all, nuclear problems are proving quite an incentive to equipment development for the power industry.

INDUSTRIAL POWER REACTORS (reactors in sizes suitable for industrial power service) are getting increasing attention. The AEC has approved a feasibility study for a small central station nuclear power plant rated 10,000 kw . . . Another study, costing industry $200,000, is being launched under AEC approval to investigate small reactor power plants and the accompanying problems of decontamination services, utilization of byproduct radiation, instrumentation, waste disposal, materials, and equipment . . . And now that the project to develop a Package Reactor for the Army is underway, it is the opinion of AEC spokesmen that "for the first time we are driving toward a small central station plant."

A NEW CONCEPT of great promise for industrial power is contained in the news that a contract has been awarded for the first study of a nuclear-powered reciprocating engine. All previous proposals for power from the atom have assumed that heat from the reactor would ultimately drive a turbine-generator, rather than a reciprocating engine.

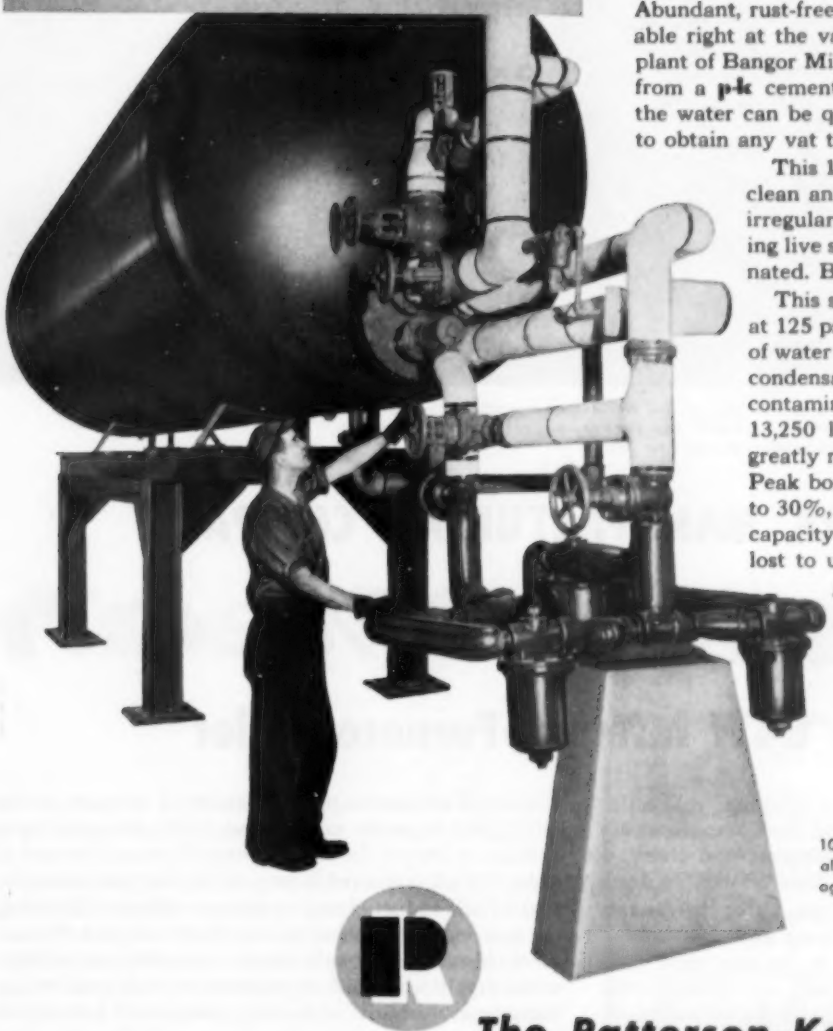
THE FUTURE of nuclear power for industry came in for comment recently by Francis C. McKune, vice president and general manager of General Electric's Atomic Products division. He said, "We have no choice but to find a new source of low-cost energy at least by 1975, and be making good use of it by the turn of the century . . . Industry is growing, expanding, building plants which are increasingly remote from urban areas. Think what atomic power can mean to those parts of our great land where coal and oil and swift water are not available or are not economically feasible as power-producing fuel . . ."

Now

BANGOR *Mills inc.*

gets

clean, rust-free, hot water without waiting from a p-k cement-lined Storage Heater



Abundant, rust-free water at 190°F. is always available right at the vat for dyers at the Nylon Tricot plant of Bangor Mills, Inc., Pen Argyle, Pa. Supplied from a p-k cement-lined hot water storage heater, the water can be quickly tempered with cold water to obtain any vat temperature from 190°F. to 60°F.

This 100% rust-free water is absolutely clean and cannot soil fabrics. The spotty, irregular dyeing that results from injecting live steam into cold water is also eliminated. But that's only the beginning . . .

This single p-k unit, working on steam at 125 psi heats as much as 10,000 gallons of water per hour from 40° to 190°. Cooled condensate is also returned clean and uncontaminated to the boiler at a rate of 13,250 lb. hourly, conserving water and greatly reducing formation of boiler scale. Peak boiler demand is also reduced 20% to 30%, a relative increase in steam plant capacity and a saving in fuel otherwise lost to uneven heating demand.

An inexpensive p-k cement-lined hot water storage installation can give *you* these savings—this added efficiency, too. Write today for full information.

10,000 gallons of rust-free water at 190°F. is always available from this p-k hot water storage heater at the Bangor Mills plant.

The Patterson-Kelley Co., Inc.

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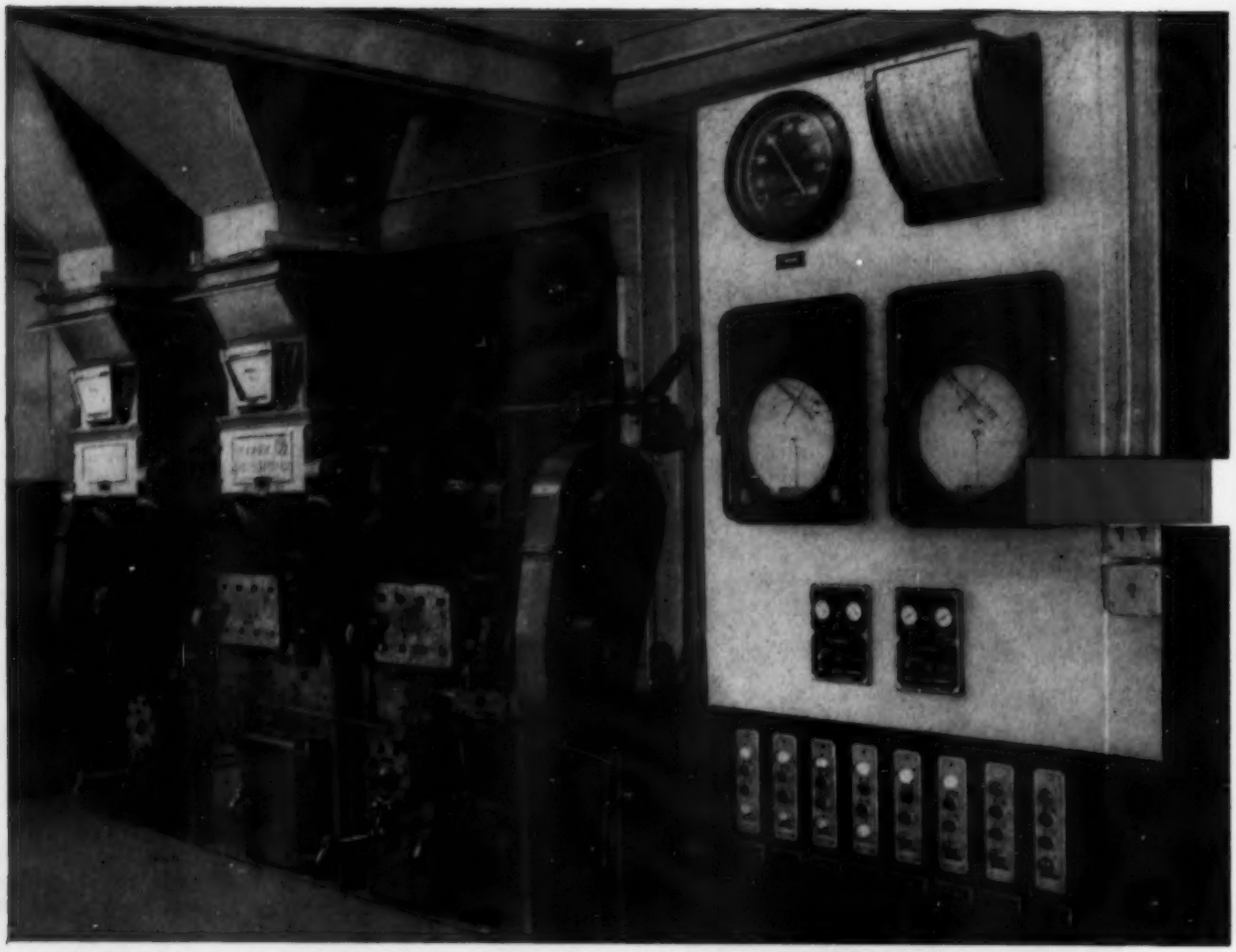


B&W Integral-Furnace Boiler with its control panel at Mill No. 3 boiler plant of Highland Park Manufacturing Company. Presently coal-fired with Detroit RotoStoker, the boiler is designed for future oil and gas firing. B. O. Vannort Engineers, Inc., are the consulting engineers for this installation.

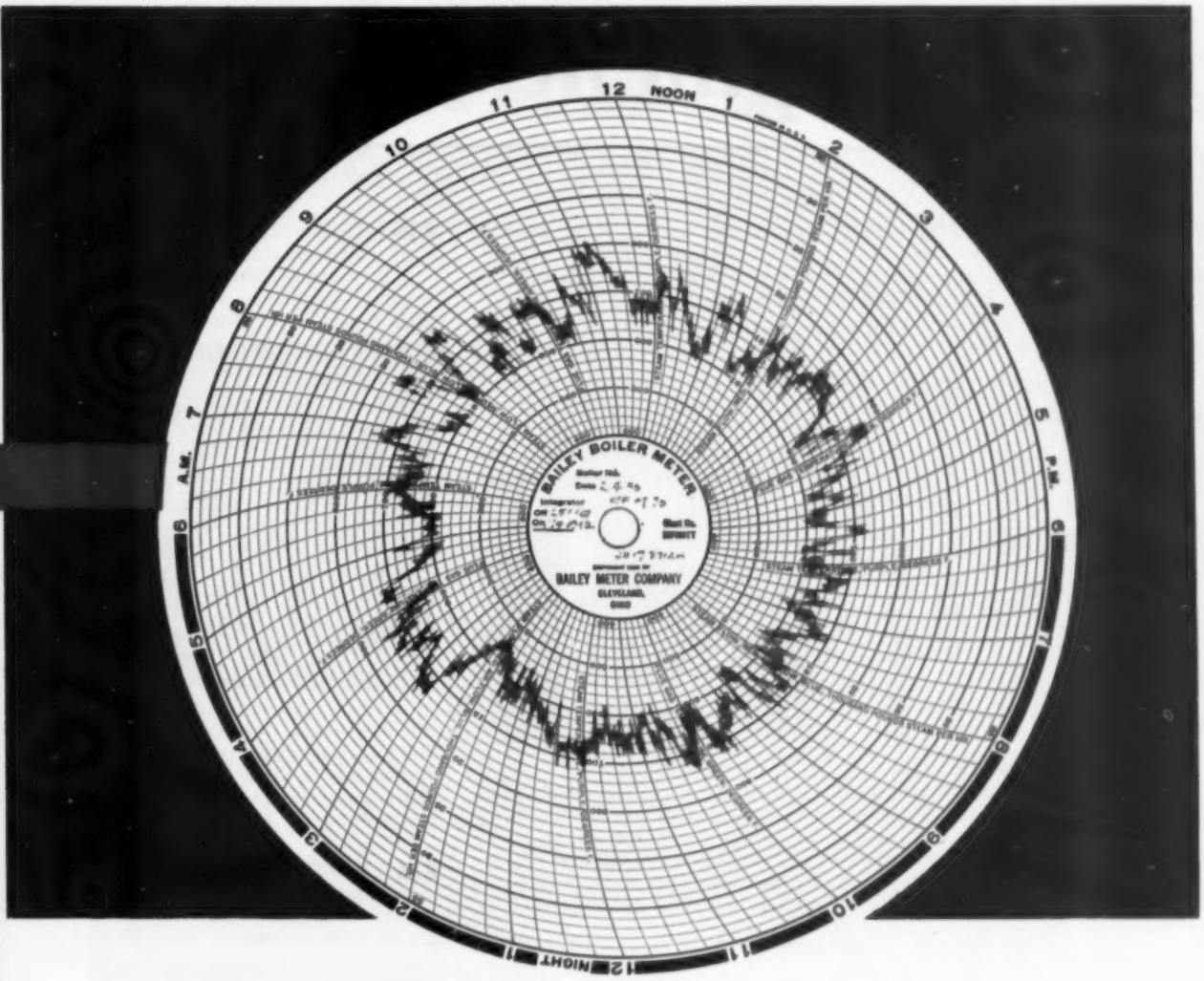
HIGHLAND PARK MANUFACTURING COMPANY

Saves 20% on

with a B&W Integral-Furnace Boiler

When a study of boiler plant costs confirmed that boiler and auxiliary facilities at Highland Park Manufacturing Company's Mill No. 3, were inadequate and costly, a B&W Integral-Furnace Boiler was installed to replace one of the two old steam units in the plant. Other charges and replacements, including steam piping and ducts and a coal-handling system, were made at the same time. And from the day the new equipment went into operation the boiler plant started to pay for itself. An indication of actual savings is shown by the 706-ton annual reduction in fuel consumption—a full 20 per cent saving and in itself strong justification for the plant's modernization.

The new B&W Boiler provides 25,000 lb of steam per hr, and 27,500 lb per hr to meet peak loads. Designed for a pressure of 250 psi, the boiler is currently being operated at about 150 psi. Coal-fired, it has provision for future installation of oil- and gas-firing equipment without disturbing the stokers, to derive full benefit from fuel price fluctuations. Also, this new unit assures a constant and reliable steam supply with quick response to the wide load swings common in the course of normal operation. It is equipped with complete controls, an alarm system and other protective devices to minimize manual operation and supervision. In addition to fuel savings, the Company reports overall



Fuel Alone

boiler efficiency consistently high, the plant much cleaner than before, and maintenance costs reduced substantially.

Highland Park Manufacturing Company and many other industrial plants in various categories have found B&W Integral-Furnace Boilers ideally suited to their steam requirements. If you are considering steam plant modernization or expansion to improve efficiency, get full details concerning B&W Integral-Furnace Boilers, available for steam requirements from 2900 to 350,000 lb per hr. Write to The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

COST-SAVING FEATURES

- Minimum floor space and headroom requirements
- High fuel economy
- Smokeless combustion
- Adaptable to all fuels and firing methods
- Economical fast steaming
- Water-cooled furnace
- Clean, dry steam at all ratings, even with high boiler water concentration
- Quick response to wide and heavy load swing demands
- Easy to inspect and clean
- High availability with least attention

BABCOCK & WILCOX

BOILER DIVISION

G-707

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new equipment

. . . . for industry and power

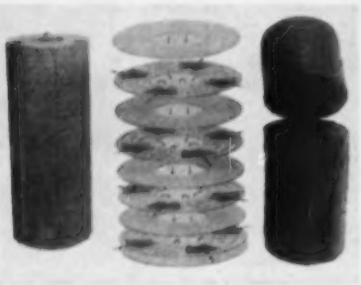
E10 FOAMED PLASTIC PIPE insulation for use on dual temperature lines to air-conditioning units is announced by Armstrong Cork Co. Called Armaflex, the material is available in tubular form so

that it can be slipped on pipes or tubing when the system is being installed. Where lines are already connected, Armaflex can be slit longitudinally, snapped on the line, and the slit sealed with an adhesive which is available with the material.

E11 HIGH-BAY LAMPS. Development of a 750-watt high-voltage lamp using an R-52 bulb, designed for use in high-bay industrial areas, is announced by General Electric Company's Lamp Div. It is designed to reduce lighting maintenance costs to a minimum, and is said to be the solution to many general lighting problems in industrial plants having high bays, or dust and dirt problems.

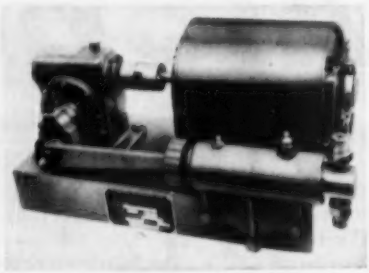
E12 CONTROL SYSTEM. Builders-Providence, Inc. announces the Synchro-Scan, a multi-function supervisory control system utilizing a single pair of signal wires. It can be supervised by one operator. Permits remote control of any combination of pumps, valves, gates, and generators from a central dispatching station. It is designed for simple installation and maintenance by local electricians and station operators.

E13 FILTER CARTRIDGES available from The Hilliard Corp. (Types F-718 and FW-718) feature greater filtering area, low pressure drop, and high dirt storage



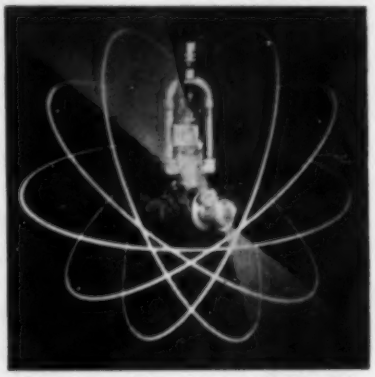
capacity. Cellulose construction makes cartridges suitable for filtering straight mineral oil or heavy duty detergent oils without removing the detergents and oxidation inhibitors from the oil.

E14 PROPORTIONING PUMPS announced by Philadelphia Pump and Machinery Co. are designed for all general water treating requirements and for economy



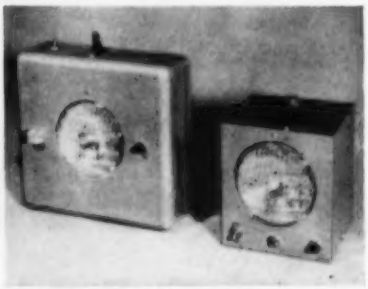
in both first cost and upkeep. Known as the Phila-Feeder, the pumps are made in simplex and duplex types for feeding from 2cc to 18.6 gph with maximum discharge pressure up to 800 psi.

E15 TANK CLEANER providing three-dimensional rotation of a high-pressure hydraulic jet is announced by Sellers Injector Corp. This rotor jet delivers two streams



of hot or cold water, with or without detergents, over the entire inside surface of any shape tank. It is available in three models for discharge capacities ranging from 600 to 6000 gph.

E16 SAFEGUARD LITE developed by Jamil, Inc. is designed to supply light by battery power when electricity fails. When



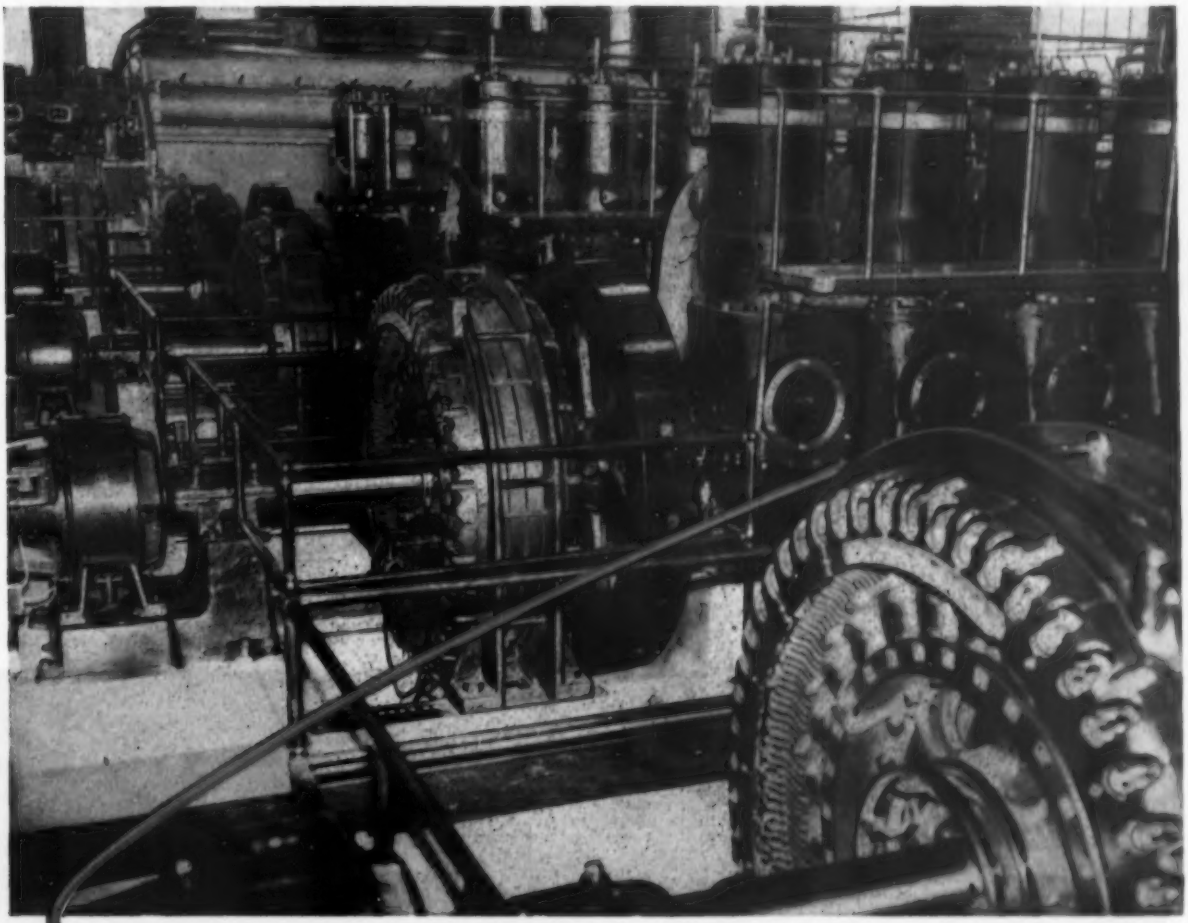
the electric power fails, battery power of the light is automatically turned on until normal electrical power is restored. Comes equipped with battery, test buttons, and six-volt sealed beam lamps.

E17 FLOOR PATCHING and resurfacing material, known as Vyniflex, developed by Flexrock Co. is said to have perfect adhesion to

(Continued on page 14)

NOTE—Each new equipment item has a key number for your convenience in asking for additional, detailed information. Circle this number on Reply Card, facing pages 34 and 74.

Resists Wear!



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"Our Welding Machines were repeatedly being shutdown . . *until we changed to Fusetron Fuses*"

"They eliminated production losses due to needless fuse blows."

"Our service shop is headquarters for the Detroit area of Fruehauf's operation. Trucks, tractors and trailers come in for repairs.

"As you know, motor carriers don't make money if they aren't hauling freight. It's our job to have the equipment rolling — and fast!

"But we were having trouble with shutdowns. Ordinary 60 ampere fuses were constantly blowing on our welding machines. We have 12 of these machines — that can be connected to 60 ampere switches located throughout the shop.

"Since many major repair jobs require welding, these shutdowns were really a serious problem for us.

"In an effort to avoid these shutdowns, we installed Fusetron fuses. Since changing, there hasn't been any needless fuse blowing on the welders. Fusetron fuses completely eliminated the trouble."

Clyde Parkins CHIEF ELECTRICIAN
Detroit Branch • Fruehauf Trailer Company, Detroit, Mich.

EVERYONE IN THE PLANT CAN BENEFIT BY USING FUSETRON *dual-element* FUSES.

FUSETRON is a trademark of the Bussmann Mfg. Co.

To Electrical and Safety Engineers
Fusetron Fuses Offer Maximum Safety

The 100,000 amp. interrupting rating of Fusetron fuses is apace with the high capacities of today's network systems — and they are adequately safe to meet future circuit growth.

Fusetron fuses reduce the expense of damaged equipment and the danger of fire and other hazards that can result from electrical faults because — they protect against short-circuits, harmful overloads and single phasing.

To Production Engineers
Fusetron Fuses Offer Increased Production

Down-time is reduced, because Fusetron fuses wipe out needless blows caused by harmless overloads or excessive heating of panels or switches.

HERE'S WHY FUSETRON FUSES GIVE ALL-PURPOSE PROTECTION

A fuse link combined with a thermal cutout — the result, a fuse with tremendous time-lag and much less electrical resistance and an interrupting rating in excess of 100,000 amps.

They have the same degree of Underwriters' Laboratories approval for both motor-running and circuit protection as the most expensive devices made.

Made to same dimensions as ordinary fuses, FUSETRON Fuses fit all standard fuse holders.

Obtainable in all sizes from 1/10 to 600 ampere, both 250 and 600 volt types. Also in plug types for 125 volt circuits.

Their cost is surprisingly low.

Write for bulletin FIS.

To Maintenance Engineers
Fusetron Fuses Offer Savings in Time and Work

Once properly installed, Fusetron fuses require no periodic inspection or down-time necessary on mechanically operated devices.

They protect against irritating interruptions of regular maintenance caused by needless blows. Unnecessary repair work is reduced because — if trouble occurs, Fusetron fuses open and warn of danger before motors or equipment are damaged.

Panels and switches are protected against damage due to poor contact heating.

To Top Management
Fusetron Fuses Offer Reduced Costs

Fusetron fuses cut maintenance costs because they are maintenance free — they increase life of equipment by guarding against damage caused by electrical faults — and they lower production costs by eliminating shutdowns due to needless blows.

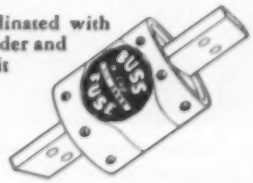
They save waste of space and money by permitting use of proper size panels and switches, instead of oversize.

FOR LOADS ABOVE 600 AND UP TO 5,000 AMPS . . . USE BUSS HI-CAP FUSES . . .

They have unlimited interrupting capacity to handle any fault current regardless of system growth.

They can be coordinated with Fusetron fuses on feeder and branch circuits to limit fault outages to circuit of origin.

Write for bulletin HCS.



Play Safe! install Fusetron and BUSS Hi-Cap Fuses throughout the entire Electrical System.

FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

BUSSMANN MFG. CO. (Division of McGraw Electric Co.)
UNIVERSITY AT JEFFERSON ST. LOUIS 7, MO.

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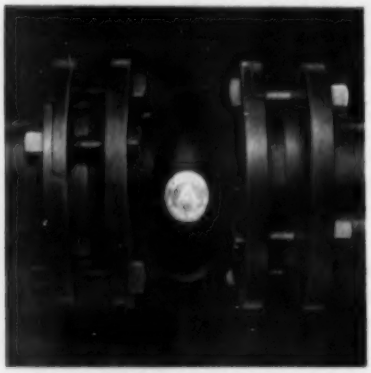
new equipment

—Starts on page 10

any clean surface—even if the surface is damp. It is designed for floors subjected to acids, alkalis, grease, and similar adverse conditions. It is ready for use in 18 to 24 hr and comes in four colors.

E18 RUBBER EXPANSION JOINTS specially designed for use with piping and flanges made by Haveg Corp. and The Duriron Co., Inc. are announced by The Garlock Packing Co. Known



as Garlock 209 Expansion Joints, they are furnished for pipe sizes from 1 to 12 in. inclusive. They can be furnished for various types of severe operating conditions.

E19 PACKAGE SUBSTATIONS. Complete outdoor package substations—from the incoming-line strain insulators to the outgoing

low-voltage feeder terminals—are announced by Line Material Co. All components are coordinated to provide a standardized well-engineered package and standard designs are available at any kva capacity.

E20 AIR METER announced by Anemostat Corporation of America gives instantaneous direct readings on air velocity, air temperature, and static pressure in

heating, ventilating, and air conditioning systems. It measures velocity from 10 to 8,000 fpm, temperature to 225 F, and static pressure directly in terms of inches of water from 0 to 8 negative and positive.

TO REQUEST ADDITIONAL DATA

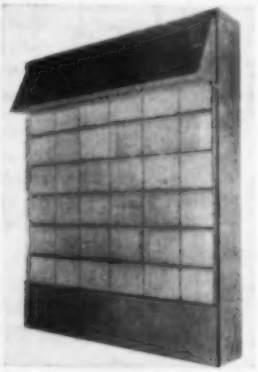
Circle key numbers on Reply Card facing pages 34 & 74. Your requests will be handled promptly.

E21 BALANCING FITTING for hot water and radiant systems developed by Sarcotherm Controls, Inc. utilizes a segment of a

circle instead of the conventional butterfly restriction. The fitting is suitable for 200 psi water pressure and is also available with integral manual air vent.

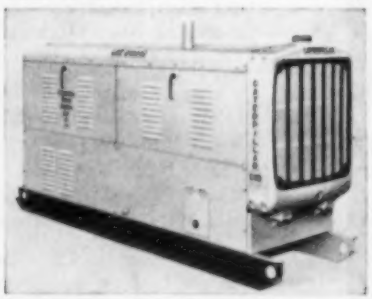
E22 MASONRY ANCHOR announced by Diamond Expansion Bolt Co. is an easy-to-use fastener for anchoring to masonry, cinder block, or concrete. Made of aluminum alloy, the anchors are of one-piece construction which permits perfect alignment in any drilled hole. Sizes are from 3/16 by ⅞ long to ½ by 3½ in. long.

E23 AIR FILTERS in 6 ft-wide section are now available from Continental Air Filters, Inc. These automatic, self-cleaning air



filters can accommodate any desired cfm capacity. Because of their wider sections, they will cut costs in multiple-section installations by reducing the number of sections needed.

E24 DIESEL ELECTRIC SETS are now available from Caterpillar Tractor Co. in a complete line of 10 mobile and skid-mounted units. Four trailer-mounted units are for



continuous duty. Five smaller units, ranging from 116 kw to 18 kw, are skid mounted. A special unit is totally enclosed, self-contained, and trailer-mounted. It has a 150-kw, 60-cycle, 3-phase, 440-volt generator plus switchgear.

E25 ALUMINUM PUTTY that shrinks less than 0.2 of one percent while hardening and will not crack in thick applications is

(Continued on page 18)

BETZ • ***A Great Name In Water Conditioning***

we're from Missouri...

. . . and for good reason!

Betz Water Conditioning Service is based on the policy that nothing is left to chance. There are no mere guesses or assumptions that conditions are satisfactory at a client's plant.

In addition to regular visits by Betz Engineers and daily water testing by plant personnel, we "double-check" results by means of more complete analyses in our own laboratories.

At regular intervals, water samples from important points throughout the plant system are secured by our engineers and forwarded to our modern laboratories. Here, experienced chemists analyze each sample until it literally breaks down and "admits the facts".

Such painstaking analyses often reveal conditions which may not be evident from plant control tests. It permits our Engineering Division to make corrective recommendations *well in advance*, thereby heading off any serious trouble which might develop. This, too, is *another* important part of Betz *completely-integrated* water conditioning service.

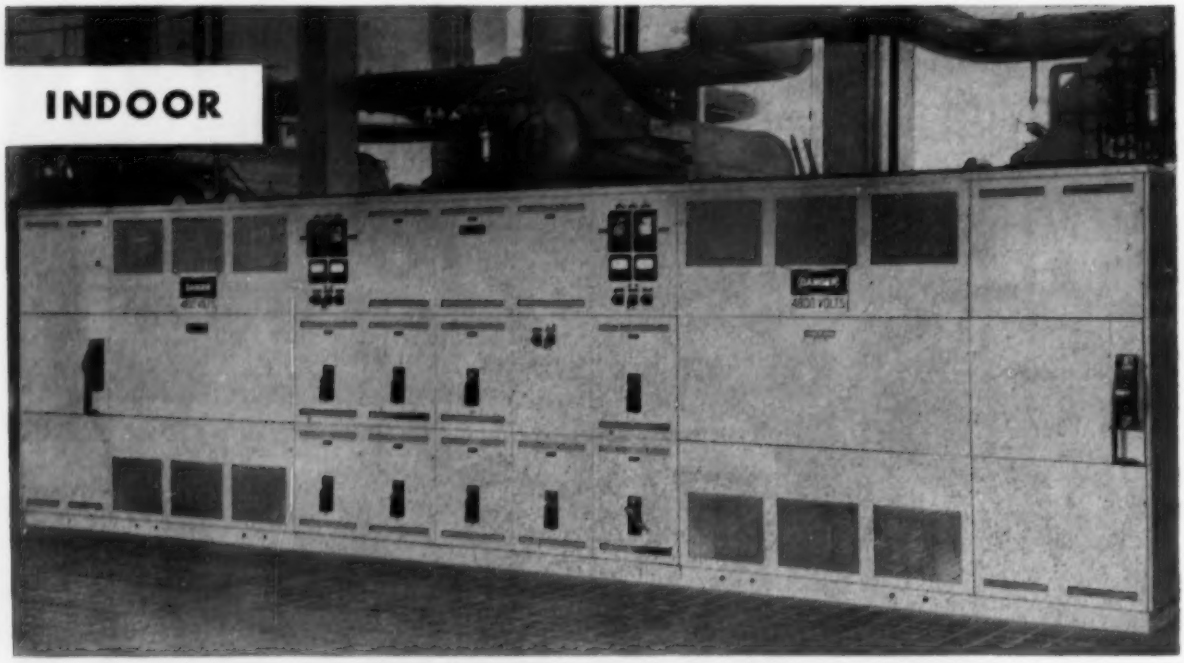
W. H. & L. D. BETZ, Gillingham & Worth Streets, Philadelphia 24, Pa.

In Canada: BETZ Laboratories Limited, Montreal 1.

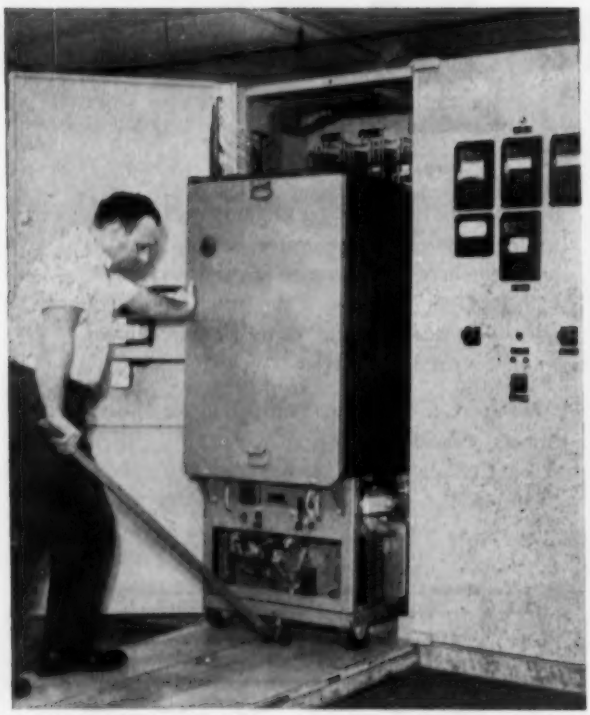
BETZ

CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

Circle 507 on Reply Card for more data

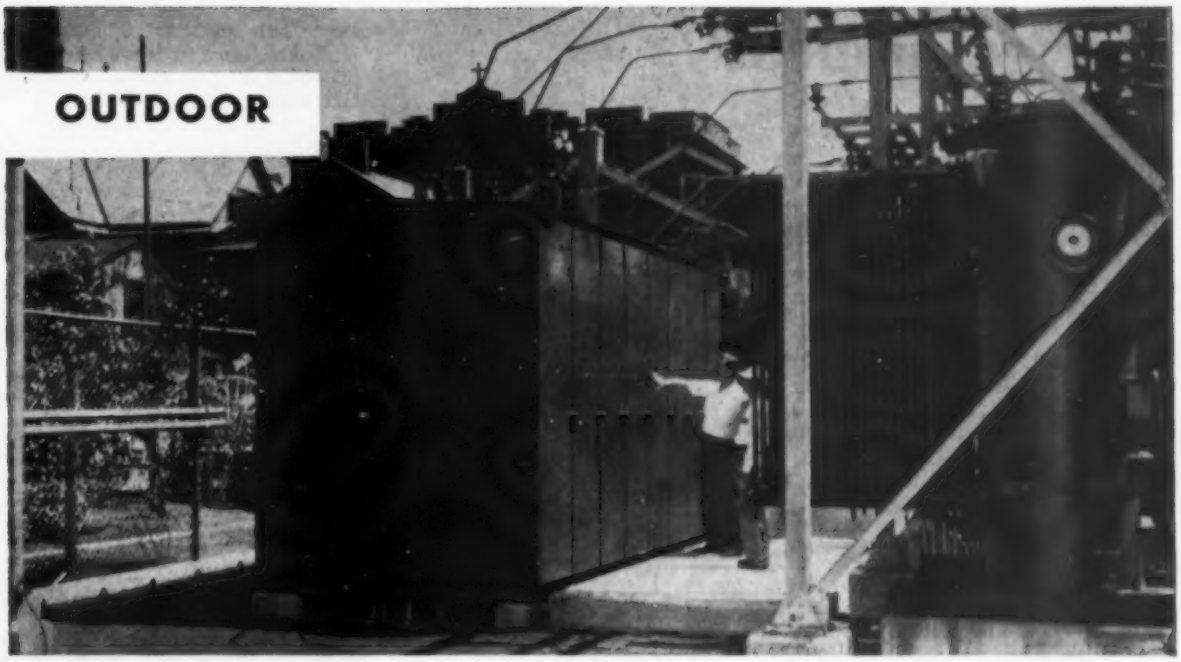


I-T-E, SINGLE SOURCE OF SUPPLY



Primary Section: Maximum protection on the primary side is assured with I-T-E Power Air Circuit Breakers. As an alternate to circuit breakers, roof bushings, throats, terminal chambers, oil cutouts, liquid disconnect switches or air interrupter switches may be furnished.

Transformer Section: I-T-E can supply any type of transformer required for a particular installation. It can be either liquid filled, nitrogen sealed, or dry type. All transformers match and line up with the primary and secondary sections to create one complete unit.



FOR COMPLETE UNIT SUBSTATIONS

Secondary Section: The secondary section consists of I-T-E switchgear. Completely interchangeable, horizontal drawout air circuit breakers are housed in a sturdy structure with completely isolated compartments, large rigidly braced bus, and a superior exterior finish.

You can buy a unit substation either of two ways: a piece at a time (the expensive way), or all at once (the economical way). I-T-E can sell you the individual elements, but recommends that substations be purchased complete, and from a single source of supply.

There are good, practical reasons for this. I-T-E's engineering assistance in over-all planning, floor layout, and choice of elements is more valuable to you when it covers the complete substation. Units are packaged and shipped ready to install without delay or complications.

There are further advantages in knowing that one dependable company stands behind your complete installation, and that all parts are designed to function as a unit.

I-T-E Primary and Secondary Unit Substations can be supplied for any application: indoor and outdoor, and in any standard rating. For details, contact the I-T-E sales office nearest you. Look in your classified directory under "Electric Equipment." I-T-E Circuit Breaker Company, Switchgear Division, 19th & Hamilton Sts., Philadelphia 30, Pennsylvania.

I-T-E CIRCUIT BREAKER COMPANY
Switchgear Division

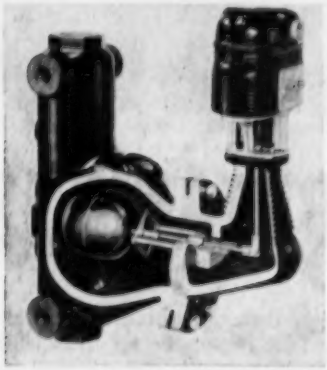
Circle 508 on Reply Card for more data

new equipment

—Starts on page 10

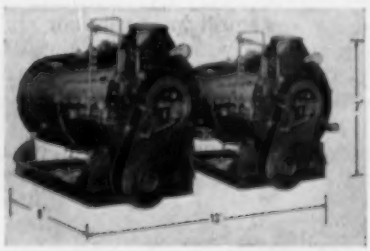
available from Smooth-On Mfg. Co. for building up metal surfaces or for caulking seams and holes in metal and wood surfaces. Known as Metalset A201, the product can be machined by any conventional method. It can be tapped or drilled.

E26 TWIN SWITCH, float-operated control for use primarily with boilers up to 250 psi is being introduced by McDonnell & Miller, Inc. It performs any or all of three functions: starts and stops boiler



feed pump as water level dictates, interrupts current to burner if water drops to emergency low level, and closes circuit to alarm if water drops to emergency level. Known as the 92 series control, the units are available to suit all operating needs.

E27 PACKAGE BOILER needs only 104 sq ft of floor area and only 728 cu ft of plant space. The twin-unit package boiler in-



stallation developed by the Cyclotherm Div. of United States Radiator Corp. delivers 10,000 lb of steam per hr. Designated the C-5000, the unit delivers 5000 lb of steam per hr, and the two units can handle fluctuating loads from 1300 to full 10,000 lb maximum. Units burn oil or gas, and can be furnished to burn both.

E28 UNION BONNET, rising stem, gate valves in the 125 to 150 lb steam working pressure classes replace solid and split wedge,

rising stem, screwed bonnet valves. The valves, developed by The Fairbanks Co., are recommended for general service on steam, water, gas, or oil lines where unrestricted flow is desired.

TO REQUEST ADDITIONAL DATA

Circle key numbers on Reply Card facing pages 34 & 74. Your requests will be handled promptly.

E29 SUPER POWERHOUSE Cement, developed by Baldwin-Hill Co., provides both insulating properties and a smooth, white finish when applied alone or over reg-

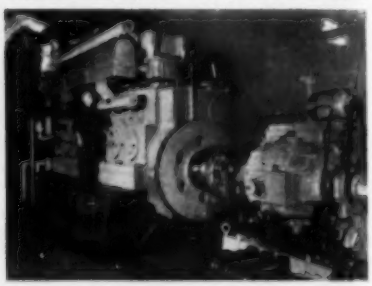
ular insulating cement, block, blanket or other forms of thermal insulation. Made of spun mineral wool, it can be used to temperatures up to 1700 F. It has a glazed white surface when finished troweled.

E30 BUILDING INSULATION that provides thermal and acoustical insulation for roofs and walls as well as attractive interior finish is announced by Owens-Corning Fiberglas Corp. Fiberglas Industrial Building Insulation is available in 24-inch widths, lengths to 96 inches, and thicknesses of 1 to 2½ inches—dependent upon thermal requirements. "K" value is .25 btu/hr/sq ft/in./degree of temperature difference at 75 F mean temperature.

E31 CONTROL INITIATING instrument announced by General Electric Company's Instrument Dept. is an automatic, all-electrical

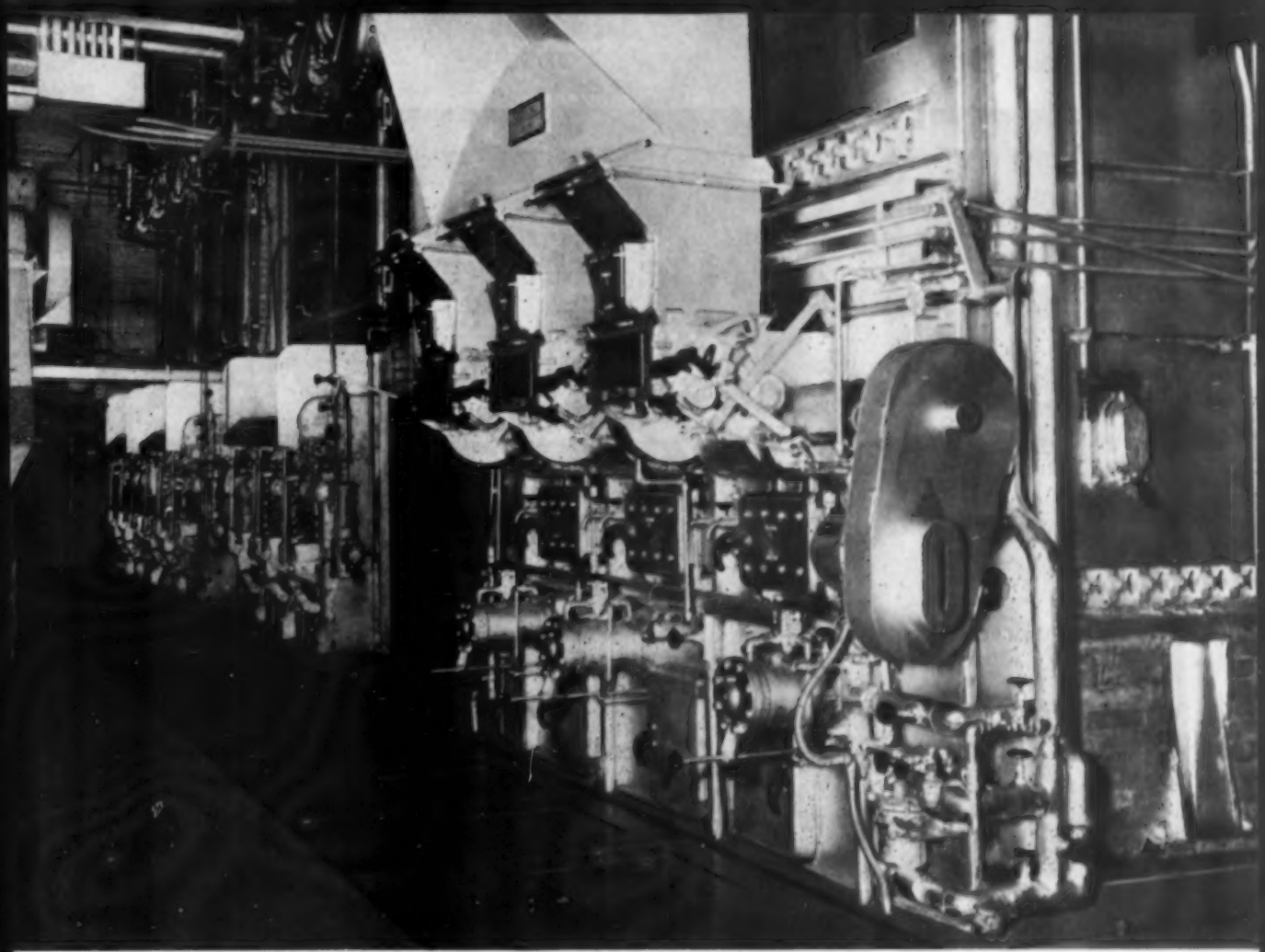
device for initiating action when a predetermined value is reached. Load relays supplied are rated as 120/240 volts, 10/5 amp, single-pole, double-throw.

E32 POWER ENGINES announced by Worthington Corp. are high-pressure, turbo-supercharged, four-cycle design,



rated from 1360 to 5000 hp at 450 rpm. Known as the SW 14 line, the units feature interchangeability of major parts between the in-line and

(Continued on page 22)



For efficiency and economy of operation, Liggett & Myers burns coal the modern way

In 1952, the steam demand of the Liggett & Myers Tobacco Co., Richmond, Va., had developed to the point where additional capacity was needed. The firm of Lockwood Greene Engineers, Inc., retained by Liggett & Myers to study the situation, recommended installing modern, automatic coal burning equipment to operate in conjunction with the original boilers. The equipment was installed.

The results have been extremely gratifying. The boiler plant now maintains constant pressure under high steam demand, the steam coal rate has increased 4.1 and there have been no operating difficulties. In addition, other benefits include reduction of labor, satisfactory air pollution control and improved performance records.

Investigate Your Fuel Costs

If you're planning to modernize your plant or build a new one—or if you are just interested in cutting fuel costs—find out how coal,* burned the modern way, compares to other fuels. Talk to a consulting engineer or your nearest coal distributor. Their advice may save you thousands of dollars every year.

facts you should know about coal

In most industrial areas, bituminous coal is the lowest-cost fuel available.

Up-to-date coal burning equipment can give you 10% to 40% more steam per dollar.

Automatic coal and ash handling systems can result in a virtually labor-free plant.

Coal is the safest fuel to store and use. No dust or smoke problems when coal is burned with modern equipment.

Between America's vast coal reserves and mechanized coal production methods, you can count on coal being plentiful and its price remaining stable.

For further information or additional case histories showing how other plants have saved money burning coal, write to the address below.

NATIONAL COAL ASSOCIATION
Southern Building, Washington 5, D.C.

Circle 509 on Reply Card for more data

How to Select an Economical Temperature Regulator

First of all, what does *economy* mean where temperature regulators are concerned? In some industries it means improvement of product or reduction of spoilage through closer control of process temperatures. In others, it means the paring down of operating expense. The price of the regulator itself is a relatively small factor.

Today's buyers are shopping for:

1. Accuracy of control — not only when the regulator is new, but throughout its service life
2. Dependability — to prevent loss of production time
3. Minimum installation and maintenance cost

Here are a few tips on what to look for when you're installing a new or replacing an old temperature regulator —

Packless construction . . . and for this reason: A diaphragm operated, packless regulator minimizes friction. There are no closely fitted parts to stick or bind because of uneven expansion or collection of foreign matter. Also, there's less maintenance, since no repacking is ever required.

A guarantee against wire drawing of the seats and discs. Insist on it. This guarantee in combination with single seat design assures you of tight shutoff; you avoid expensive steam losses as well as loss of product in a process application.

Broad control range. In a standard regulator you should expect a control range of 100 F. And make sure the unit you select has a vapor tension thermostat that can take over-temperatures of at least 100 F.

Easy maintenance. Why ask for grief? Your temperature regulator should be basically simple in design so that it can be serviced by average plant personnel. All parts should be readily accessible for testing and cleaning.

Double duty. There's no point in buying a separate pressure regulator when you can select a temperature regulator that combines both temperature and pressure control within the same unit.

Self-operating. Make sure you get a regulator that operates on its own initial pressure. By doing so, you avoid the purchasing and maintenance of an air compressor plus air piping, and you're sure of uninterrupted operation during electric power failures.

• • • •

All of these points are important to you when it comes to selecting an economical temperature regulator. Perhaps you didn't realize you *could* expect so much. And perhaps you didn't realize that Spence Temperature Regulators offer all these features and more. May we send you our Bulletin T 500 containing further details? 6E 150

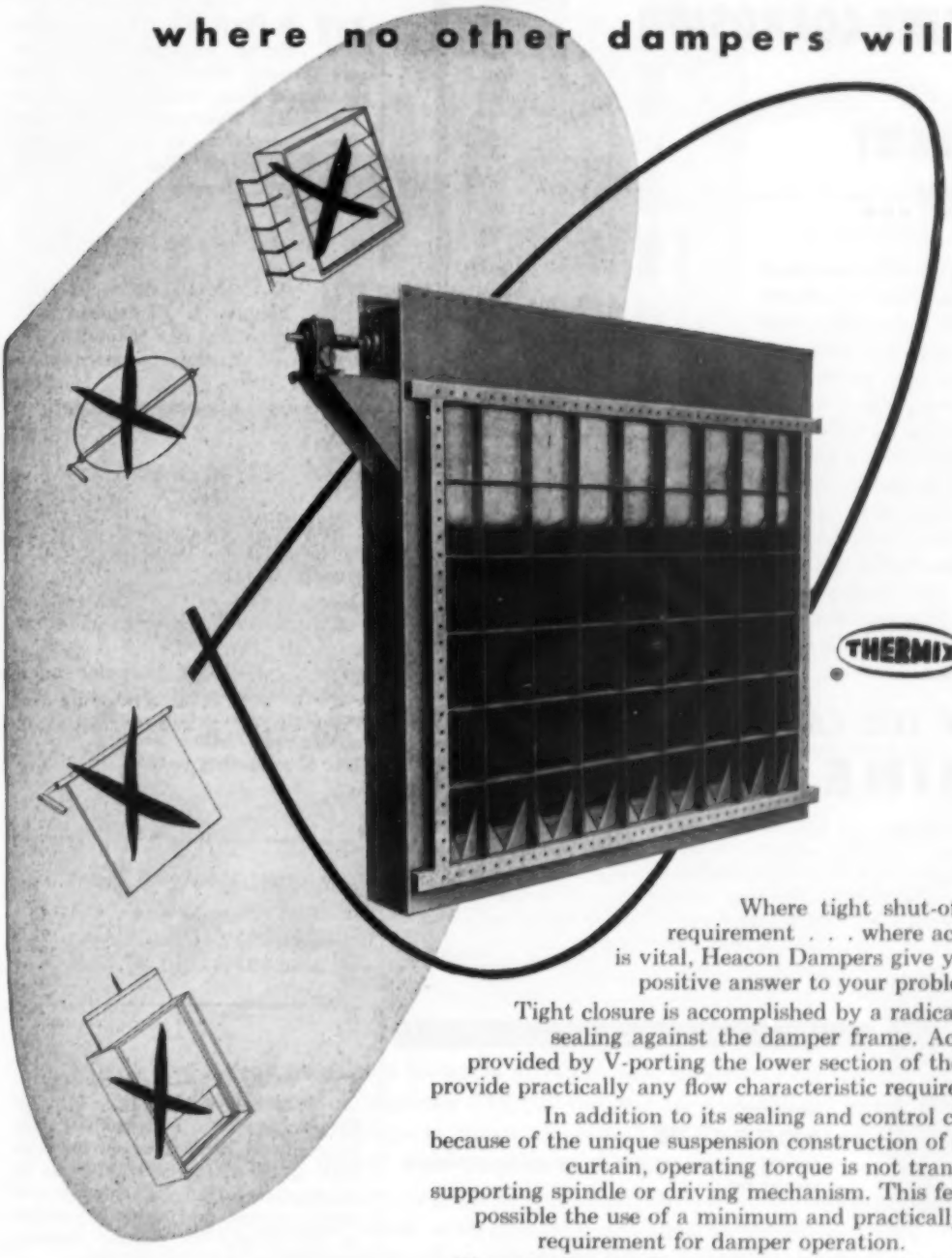
SPENCE ENGINEERING COMPANY, INC.
Walden, New York

Circle 510 on Reply Card for more data

THE FINEST DAMPER THAT MONEY CAN BUY

HEACON DAMPERS *are specified*

where no other dampers will work



Where tight shut-off is an absolute requirement . . . where accurate control is vital, Heacon Dampers give you the only positive answer to your problem.

Tight closure is accomplished by a radical method of sealing against the damper frame. Accurate control is provided by V-porting the lower section of the frame to provide practically any flow characteristic required.

In addition to its sealing and control characteristics, because of the unique suspension construction of the sealing curtain, operating torque is not transmitted to the supporting spindle or driving mechanism. This feature makes possible the use of a minimum and practically constant power requirement for damper operation.

Thermix, Project Engineers for Heacon will be glad to help solve your damper problems. Why not contact them today.

Project Engineers

THE THERMIX CORPORATION

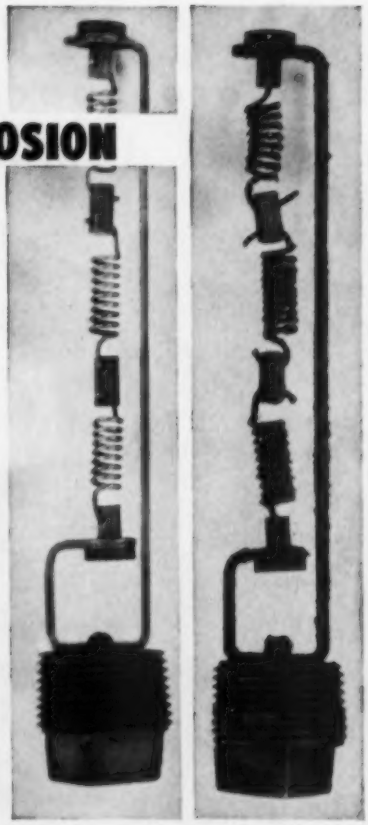
GREENWICH, CONN.

(OFFICES IN 38 PRINCIPAL CITIES)

Canadian Affiliates: T. C. Chown, Ltd. 1440 St. Catherine St. W., Montreal 25, Quebec. 983 Bay St., Toronto 5, Ontario, Canada

Circle 511 on Reply Card for more data

HERE'S HOW RETURN LINE CORROSION REDUCES POWER PLANT EFFICIENCY...



Return line corrosion is one of the most critical problems in maintaining economical, efficient power plant operation. To demonstrate what corrosion can do in steam and condensate return lines, we show here "before" and "after" unretouched photographs of N.D.H.A. Corrosion Testers. This is a test* developed by the American Society for Testing Materials in cooperation with the National District Heating Association. Bird-Archer supplies and analyzes these testers. Photo at left shows a Tester before installation. Photo at right shows a Tester after it had been installed for 60 days in the return line. (*Standard Method of Corrosivity Test of Industrial Water, NDHA Method, ASTM Designation 935-49).

HERE'S HOW YOU CAN ELIMINATE THIS WASTE WITH AMINE TREATMENT

Bird-Archer Amine Treatment is an easy, effective and economical way to eliminate corrosion troubles. Amines raise the pH value of the return condensate to the point whereby the corrosion potential is negative. In addition, amines provide a surface protection for the metal itself which further inhibits corrosion. In scores of plants, Bird-Archer Amine Treatment is paying a profit on its cost through savings in piping replacement and maintenance work.

WRITE FOR
BULLETIN CP-100
AND THE NAME OF THE BIRD-ARCHER SERVICE ENGINEER NEAREST YOU.

LABORATORIES ENGINEERS · CHEMISTS

BIRD-ARCHER
WATER TREATMENT

THE BIRD-ARCHER COMPANY, 4337 N. AMERICAN ST., PHILADELPHIA 40, PA.
NEW YORK • CHICAGO
IN CANADA: The Bird-Archer Co., Limited, Cobourg, Ontario
BIRD-ARCHER COMPANY OF CALIFORNIA, San Francisco

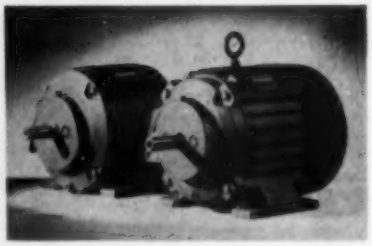
Circle 512 on Reply Card for more data

new equipment

—Starts on page 10

E33 WATER-TIGHT enclosures for all combination linestarters through NEMA size 2 are now available from Westinghouse Electric Corp. Fabricated from sheet steel, the enclosures are lighter and easier to install than conventional cast iron enclosures.

E34 A-C MOTORS—Reliance Electric & Engineering Co. announces a new line of totally-protected a-c motors in three categories: fan-cooled, corrosion-proof, and explosion-proof. The units offer complete protection against drip, splash, and falling objects regardless of mounting position.



TO REQUEST ADDITIONAL DATA
Circle key numbers on Reply Card facing pages 34 & 74. Your requests will be handled promptly.

E35 POROUS—silver bearing liner developed by Micro Metallic Corporation from sintered wire can be made to carry bearing loads as high as 50-75 percent of those of solid silver. Can be impregnated with various lubricants. Available in flat sheets for custom forming into half or full bearing liners.

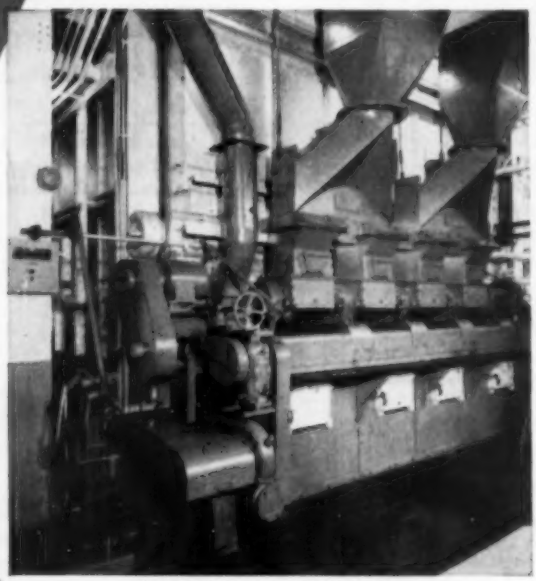
E36 ALUMINUM SHEATHED, Okotherm-insulated cable is signed for continuous operation at 150 C and up to 200 C under certain conditions. Main advantages are

(Continued on page 24)

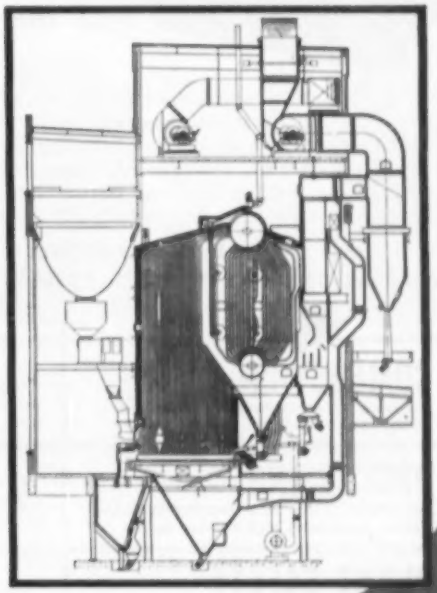
Detroit RotoGrate Stoker

SELECTED FOR TIRE PLANT

The B. F. Goodrich Company, Oaks, Pa.



Detroit RotoGrate Stoker in
B. F. Goodrich plant at Oaks, Pa.



This Detroit RotoGrate Stoker is installed with a Wickes two drum Steam Generator, capacity 115,000 lbs. per hour at 300 psi and 440° F. Design is based on using 350° F preheated air, when burning Fairmont District West Virginia coal. This is part of an expansion program at this plant. Detroit RotoGrate is an advanced spreader stoker with specially designed overlapping grates that move slowly forward, discharging ash at the front. Any Bituminous coal or Lignite, and many types of refuse are successfully burned. High burning rates per square foot of grate and exceptional flexibility make this stoker popular. Detroit RotoGrate will save you money—improve your operation.

DETROIT STOKER COMPANY
GENERAL MOTORS BLDG.—DETROIT 2, MICH.
District Offices in Principal Cities • Works at Monroe, Mich.

DETROIT SINCE 1898 STOKERS

7106

Circle 513 on Reply Card for more data

NEW
Arnold O. Beckman
MODEL F3
OXYGEN ANALYZER

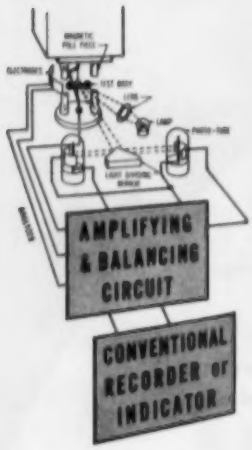
with the meter on the door

New convenience has been built into the well-known F3 Oxygen Analyzer . . . a meter on the door provides readings at the sampling point for making calibration checks, process changes, etc. In fact, complete analyzing, calibrating and indicating components are now incorporated into the single F3 unit—at no extra cost!

Use The Model F3

ON OPERATIONS LIKE THESE . . . TO MAKE SAVINGS LIKE THESE

COMBUSTION Boilers, Kilns, Direct-Fired Heaters, Stills, etc.	*Higher combustion efficiencies, at lower fuel costs*
PROCESSING Air Liquifraction . . . Processing Butadiene, Acetylene and Similar Gases	*Better product quality with minimum oxygen or air contamination*
PLANT SAFETY Hydrogenation, Hydrofining, Gas Compressors, Sulfur Grinding, etc.	*Control explosive atmospheres, reduce fire risks, minimize plant and personnel hazards*



Unique Operating Principle

The various applications highlighted above are only a few of the many ways Arnold O. Beckman Oxygen Analyzers—industry's great new profit builders—are being used by progressive operators to boost profits, cut costs.

These are the *only* oxygen analyzers that *continuously* measure process streams by an advanced magnetic principle that provides *direct physical measurement of the oxygen itself*—not of some secondary relationship.

Heart of the unit, as illustrated, is a dumbbell-shaped test body suspended in a magnetic field. Sample gas surrounding this test body causes it to rotate in the field, depending upon the oxygen content of the gas. The movement of a light beam, reflected by a small mirror on the test body, is measured by simple electronic circuits . . . and the result indicated directly on a conventional recorder or indicator. It's simple, positive, accurate!

No chemicals—filaments—catalysts cams—complicated mechanical parts!

***Send for Helpful Free Literature** which describes this unique operating principle in detail—explains its many advantages and applications. When writing, outline your particular operations—we'll gladly supply specific information.*
Ask For Data File 16C-55

FEATURES OF THE F3

Many Ranges: Full scale ranges of 0-5%, 0-10%, 0-15% O_2 and higher.
Accuracy: 1% of full scale.
Multi-Ranges: Any instrument may be supplied with two or more ranges.

***Note:** For ranges narrower than 0-5% O_2 ask about the Model G2.*

Arnold O. Beckman INC.
Instruments for Science and Industry
1020 MISSION STREET
SOUTH PASADENA, CALIFORNIA

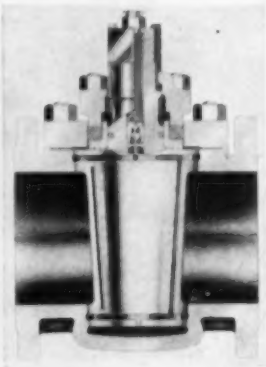
Circle 514 on Reply Card for more data

new equipment

—Starts on page 10

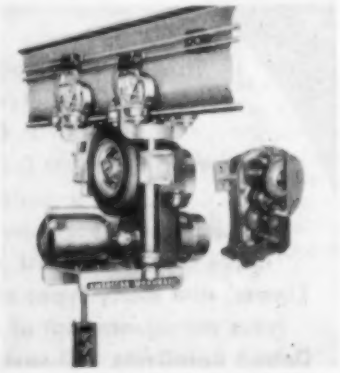
flame and heat resistance, no conduit and related "pull-in" problems, light weight for easy handling, high dielectric strength, moisture and ozone resistance, small diameter, and corrosion resistance. The Okonite Co.

E37 PLUG VALVES. Longer life, ease of operation and adjustment, and positive pressure sealing are features of the lubricated plug



valve announced by The Ohio Injector Co. These OIC plug valves are available in steel (150- and 300-lb pressure classes) and in semi-steel, (150 through 800 lb) W. O. G. in sizes ½ to 12 in.

E38 MONORAIL DRIVE UNIT. To propel a hoist or other carrier on monorail track or crane



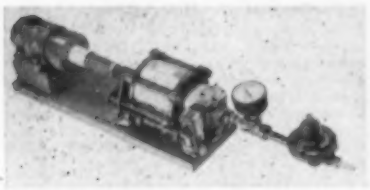
bridge, American MonoRail Co. has developed this drive unit to meet requirements for constant service, exact delivery cycles, grade travel or movement of loads up to 5 tons. Power consumption and mainte-

new equipment

—Starts on page 10

nance is held to a minimum. Speed range is from 35 to 350 ft per min. Power range is from ¼ to 2 hp.

E39 NEW PUMP announced by Hills-McCanna Co. takes its power from double-acting air cylinder to provide quick starts and positive stops at high or low speeds. Volume to be pumped is controlled

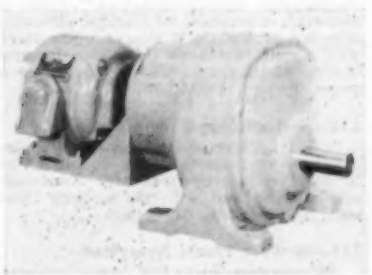


by stroke length adjustment and by controlling air supply pressure or speed of actuating the four-way valve. Known as the "UP" pump, it can be furnished with necessary components for complete liquid feed system.

TO REQUEST ADDITIONAL DATA

Circle key numbers on Reply Card facing pages 34 & 74. Your requests will be handled promptly.

E40 SPEED REDUCER. Sterling Electric Motors, Inc. announces that its Slo-Speed gear-motor speed reducing element is now also offered for separate-motor mounting. Gear unit can be mounted



on floor, wall, or ceiling with the shaft horizontal or vertical without modification. The separate motor reducer can also be supplied with any foot-mounted motor: drip-proof, totally enclosed fan-cooled, explosion-proof, wound rotor, direct current.

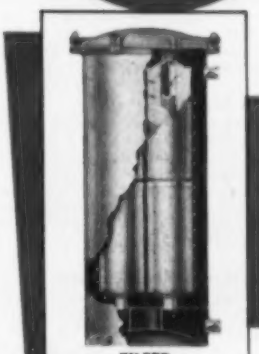
Clean Oil

SAVES YOU MONEY!

HILCO

OIL MAINTENANCE EQUIPMENT

. . Keeps your Oil and Equipment Clean



FILTER

Furnished in capacities from 0.1 to 750 gpm. Various cartridges available for mineral and inhibited detergent oils.

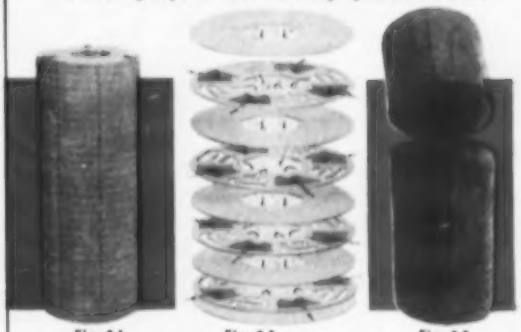


Fig. # 1 Fig. # 3 Fig. # 2

HILCO FILTER CARTRIDGES

The result of much research in the field of lubricating, fuel and industrial oil filtration, the new patented HILCO Filter Cartridges meet the need for tremendous filtering area, low pressure drop and high dirt storage capacity. Above: Fig. 1 is a new cartridge; Fig. 2 is a used cartridge (note that pockets are completely filled and the outer surface covered with solids); Fig. 3 shows the flow of oil, the dark area represents dirty oil passing into the pockets while filtered oil (white area) passes into "S" shaped section.

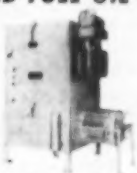
HILCO Purification Means Complete Oil Purification . . .

You get absolute removal of sludge, acids, carbon, water and fuel dilution with a properly selected HILCO. Clean oil saves you money. Expensive maintenance is reduced, equipment shut-downs practically eliminated, lost man hours and cuts in production become a thing of the past. HILCO continuous, all electric, automatic purification keeps your oil clean and in top condition at all times. You receive the full capacity and economy of your equipment.

HILCO offers a wide range of oil purification units to meet every oil conditioning problem. HILCO units are manufactured in both stationary and portable models. Write us about your purification needs . . . recommendations are given with no obligation. Let HILCO put its 25 years of experience in oil purification to work for you.

THERE'S A HILCO FOR EVERY LUBRICATION AND FUEL OIL FILTERING PROBLEM

Oil Reclaimer



Purifier Re-Refiner

High Capacity Reclaimer

WRITE TODAY FOR THE NEW HILCO CATALOG

• Recommendations at no obligation!!

THE HILLIARD Corporation

105A W. FOURTH ST. • ELMIRA, NEW YORK

IN CANADA: Upton-Bradeen-James Ltd., 890 Yonge St., Toronto; 3464 Park Ave., Montreal

Circle 515 on Reply Card for more data

new bulletins

. . . . for industry and power

200—Better Ash Handling

Boiler plants can enjoy efficient ash handling with the use of the system described in Data Sheet Za. The system is designed to convey boiler bottom ash and fly ash in a dry state to a temporary storage silo for ultimate disposal. It employs a steam jet exhauster to produce necessary vacuum. The silo, furnished with an unloader that mixes water with the ash, is also covered. Four pages. The Allen-Sherman-Hoff Co.

201—Flexible Hose Is Vital

Flexible hose assemblies play a vital part in your plant in hydraulic systems and in conveying lubricants, coolants, cutting oils, process liquids, and other fluids. Bulletin 55 contains engineering data plus complete description and specifications of industrial hose assemblies and related equipment. Twenty-four pages. J. N. Fauver Co.

202—How Steam Turbines Work

For a clear picture of how single-stage steam turbines operate, you will want Bulletin 1954C. Information on availability of various frames for single-stage applications, details on variable speed governers, and other features are included. Eight pages. Worthington Corp.

203—Screw-on Sight Flow Indicators

Sight flow indicators that can be easily and inexpensively installed in any pipe line from ⅛ to 2 in. NPT are shown in Catalog Sheet 283. Two pages. Jerguson Gage & Valve Co.

204—Versatile Instant Hose Coupling

Save money by standardizing with the versatile "E" coupling. This is explained in Sheet 250. Cross-sectional drawings illustrate construction that makes it possible for these couplings to pay for themselves for high-pressure systems, for gravity flow systems, and for vacuum systems. Two pages. Snap-tite, Inc.

205—Find Out Your Air Wastage

"A Better Air Power System," Folder 213A points out that power losses in compressed air lines are frequently as high as 20 to 30 percent. It describes just how to go about finding out if more air is being wasted than the repair and renovation of the distribution system would cost. Six pages. Ingersoll-Rand Co.

206—Basic Rotary Pump Styles

Handling liquids a problem in your plant? It doesn't have to be if you use rotary hand pumps as described in Bulletin 320. Photos show various types of pumps in use for fueling plant and field equipment, and for dispensing liquids in plants. Four pages. Blackmer Pump Co.

207—Get Up-to-date on Welding

Things you should know about West-Ing-Arc, newest of all MIG welding processes are told in Bulletin B-6525. Physical properties of the welds, cost, and what this process can do for you are discussed. Eight pages. Westinghouse Electric Corp.

208—Revised JIC Hydraulic Standards

Your personal copy of the JIC Hydraulic Standards for Industrial Equipment, including complete, unabridged revisions made at the January '53 meeting of the JIC is available. It is punched for insertion in standard catalog binders. Twenty pages. Miller Fluid Power Co.

209—Modern Brazing Methods

Application of major brazing methods in joining metals using silver alloys and filler metals, fluxes, and gas atmospheres is discussed in Manual ADC847. Subjects include silver brazing procedure, selection of brazing and filler metals, design of various joints, and assembly. Twenty-four pages. Air Reduction Sales Co.

210—New Battery Specifications

Battery trouble? Send for Specification Bulletins CP-536-Rev. 1 and CP-537-Rev. 1 covering C&D's complete line of lead-calcium and lead-antimony batteries for control, switchgear, and auxiliary power application. Specifications are included. C&D Batteries, Inc.

211—Get Free Boiler Survey

Here's how to get a boiler survey without obligation. Write for this bulletin covering the new CB self-contained boiler. Illustrations of installations, cut-away views of the boiler, and articles on how the units have proved themselves in specific applications are included. Four pages. Cleaver-Brooks Co.

212—Simplifies V-drive Selections

V-drive selections can now be made quickly and accurately using new horsepower rating and improved rating techniques, as adopted by multi-v-belt drive and rubber manufacturers associations. Get Bulletin 50-B containing simplified formulas for standard quarter-turn and V-flat drives plus tables of drives. Fort Worth Steel & Machinery Co.

213—Chart Shows Transformer Data

Type UD distribution transformers, ranging from 3 to 100 kva are detailed in Bulletin 135. Chart shows electrical and mechanical characteristics for standard ratings. Engineering data include outline dimension drawings, support lug and hanger details, bushing terminal sizes, and standard low-voltage connections. Eight pages. Uptegraff Manufacturing Co.

214—Belt-less Vibration Control

Interested in efficient, economical vibration control without bolting? Bulletin K5A describing Elasto-Rib isolation material will tell you whether or not this material can be applied to your particular problems. Loading charts, installation and arrangement drawings, specifications, and photographs show typical installations. Four pages. The Korfund Co.

215—Continuous Filter Developments

What do you filter? Bulletin 103B describes rotary vacuum filters for better cake quality, lower cost, and continuous filtration. Text explains how the filter operates, tells of its many applications in processing of chemicals, food products, industrial wastes, and paper and pulp. Twenty-four pages. Filtration Engineers, Inc.

216—Mortar Joints Repaired Simply

These seven simple steps for repairing worn or corroded mortar joints of brick or tile floors are presented in Bulletin E-37. Procedure involves use of non-shrink, Embeco pre-mixed mortar. The Master Builders Co.

217—Saves Feedwater and Btu's

Recover practically all of the heat of the blowoff water in a continuous blow-off system. Bulletin 5700 uses diagrams and text to explain how this steam may be used to heat feedwater in an open or deaerating heater and how it may be condensed in a closed heater or flash condenser to heat feedwater at a point beyond the deaerating heater. Cochrane Corp.

218—Quick Reference for Packing

Having trouble selecting the proper packing for a specific problem? This catalog outlines a complete line of rod and sheet packings, gasket cutters, and accessory items to meet almost every industrial requirement. Charts give quick reference material. Forty-eight pages. The Alipax Company, Inc.

219—How to Select Air Breakers

"Selection and Application of Federal Pacific Air Circuit Breakers," gives a thorough discussion of factors affecting selection of the DMB line of low-voltage air circuit breakers including special charts of time-current curves. Sixteen pages. Federal Pacific Electric Co.

220—Self-sticking Safety Signs

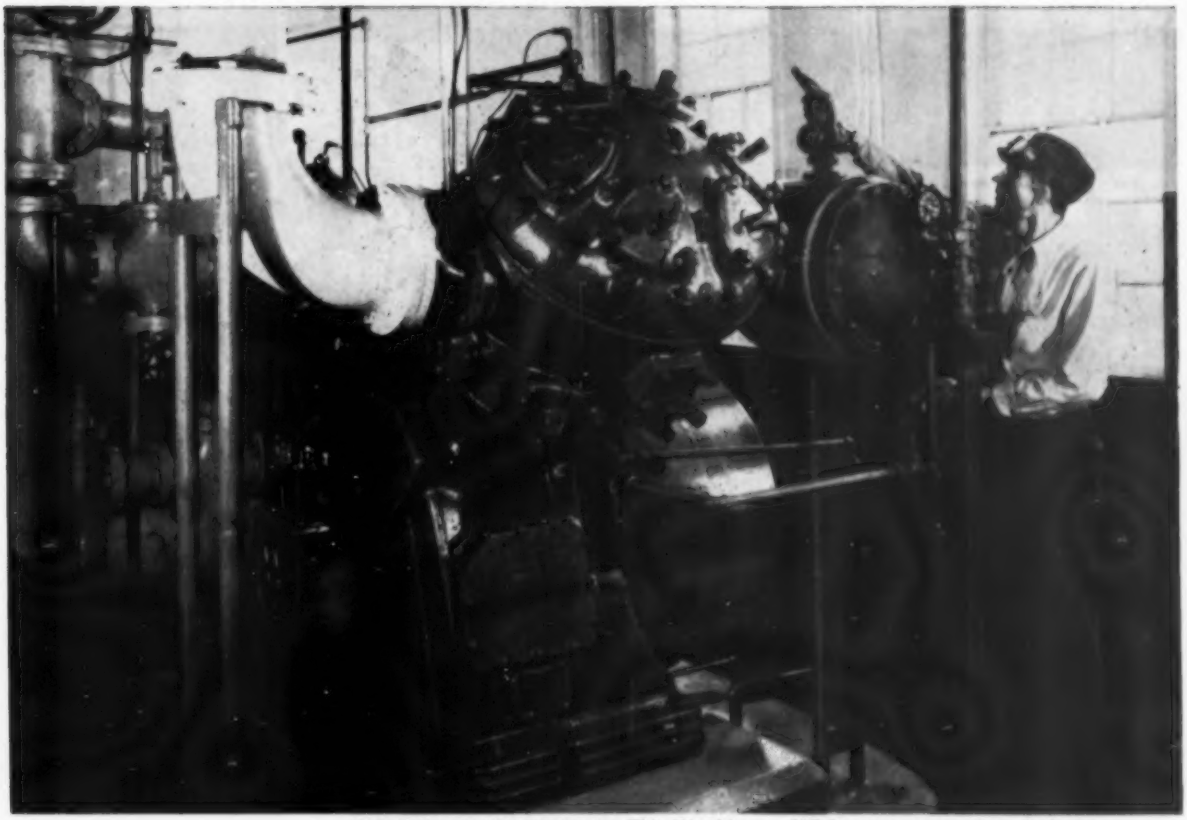
"Accident Prevention Signs." Bulletin 145-C shows available signs, enabling you to make up message necessary. Free samples will be sent with the bulletin. Sixteen pages. W. H. Brady Co.

221—Newest Paints Described

"Subox and Subalox Anti-Corrosive Paint — 30th Anniversary," replaces the 25th anniversary issue you have in your files. It covers these paints as previously

(More New Bulletins on page 30)

NOTE — Each new bulletin item has a key number for your convenience in asking for a free, personal copy. Circle key numbers on Reply Card facing pages 34 and 74.



WORKING ON THE RAILROAD. This Worthington YC-2 compressor tests and charges air brakes *fast* in the New York Central Railroad's Dewitt Car Shop, Syracuse, N.Y.

This air compressor saves you money on first cost and upkeep

It's the Worthington YC-2 compressor, built to keep going on all kinds of duty — in repair shops, factories, foundries, mines, smelting plants, railroad yards — wherever a *dependable, economical* air supply is essential.

What makes the Worthington YC-2 so good? Features like these:

1. FEATHER* VALVE. Every YC-2 is equipped with Worthington's exclusive Feather Valve—*lightest, tightest, most efficient* valve made. Result: real savings in power costs.

2. FIVE-STEP VARIABLE CAPACITY CONTROL. The YC-2 is the *only* angle compressor with 5-step control in the 100, 125 and 150 hp sizes. More power economy.

3. SMALL SIZE. The YC-2 requires *less than one-quarter* the foundation normally required for a horizontal compressor of the same capacity. And erection costs are cut because the YC-2 comes completely assembled.

Maintenance is no problem with Worthington's YC-2, by the way. It's designed so that parts replacement (which isn't often necessary) is quick and easy. Matter of fact, many of these compressors operate continuously while unattended.

Why not hand your compressed air problem over to your nearest Worthington district man. Or write to Worthington Corporation, Water-Cooled Compressor Division, Harrison, N.J. Ask for Bulletin L-676-B1.

*Reg. U.S. Pat. Off. K-4.2

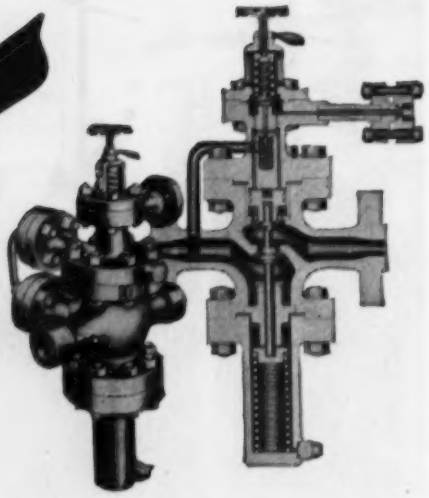
WORTHINGTON

Only Worthington Compressors give you Feather Valve Performance

Y-Types • Balanced Angle • Horizontal • Portable • Radial • Gas Engine Compressors

Circle 516 on Reply Card for more data

the PRESSURE'S ON!



STEADILY, CRITICALLY, AUTOMATICALLY, with

LESLIE

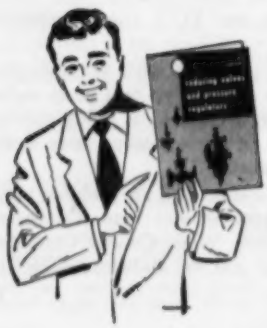
PRESSURE REDUCING VALVES

Now you can handle high pressure drops without costly, complicated two-stage reducing stations. Handling up to 1500 psi 1000° F inlet steam, the single-seated, internal pilot, piston operated valve has *proven* itself in high pressure central station service, as well as in lower pressure industrial service. High pressure applications include steam to auxiliaries, air jets and steam soot blowers. List of central station users available on request.

Engineers have put their reliance on Leslie for the best in design, materials and workmanship—in all kinds of industrial applications—for more than 55 years.

Send for the bulletin described below today.

- **For Steam, Air, Gas**
- **99% Accuracy of Regulation**
- **Instant Reaction to Flow Change**
- **Stellited Seating Surface**
- **Positive Dead-End Shut-Off**
- **Interchangeable Parts**



BULLETIN 5302

Provides latest engineering data on all classes of Leslie Pressure Reducing Valves—assists you in planning and specifying for optimum performance. Yours on request.

TYPICAL PRESSURE RANGES

CLASS	BODY MATERIAL	SIZES	INLET STEAM PRESSURES	REDUCED PRESSURE RANGE
LLK	Cast Iron	½"-6"	25-250	2-35
LK	Cast Iron	½"-6"	25-250	10-235
LL-3	Cast Bronze	½"-4"	25-300	2-35
L-3	Cast Bronze	½"-4"	25-300	10-285
LL-4	Cast Bronze	5"-6"	40-300	5-35
L-4	Cast Bronze	5"-6"	40-300	20-275
HS-2	Cast Carbon Steel & Cast Alloy Steels	½"-3"	300-750	100-600
HS-3		1"-3"	300-1500	100-600

TRADE LESLIE MARK

LESLIE CO., 263 Grant Avenue, Lyndhurst New Jersey

Circle 517 on Reply Card for more data

Looking for the right packing for your centrifugal pumps?

For shaft speeds to 1750 RPM Johns-Manville Centripac seals better

WEAR on centrifugal pump shafts as well as on oscillating and rotating rods of other equipment is minimized by J-M Centripac. This is because the square cross section of this packing provides the maximum contact surfaces. Thus, it insures a tight seal with the least friction and gland pressure.

Because Centripac is plaited square it retains its shape indefinitely, thus maintaining maximum surface contact for long periods of time. It is made from long-fiber asbestos yarn, thoroughly lubricated and graphited. It seals against fresh or salt, hot or cold water, oil, ammonia, brine, gasoline, and certain weak acids and other chemicals. Because of its wide application, it is a favorite of plant men everywhere.

For general service, Style #7 Centripac is recommended. It contains no wire, is soft enough to conform readily to the packing space, and stands up well in service. It comes in coil form, Style #C-7 and Ring form, Style #R-7. Sizes $^{3}/_{16}$" and up.

For higher shaft speeds, J-M Plastic Packings reduce friction and scoring of shafts and sleeves

Higher centrifugal pump speeds make friction increasingly important in packing and shaft life. That is why J-M Plastic Packings have been designed to have the homogeneous structure and low friction so essential to long packing life in this service.

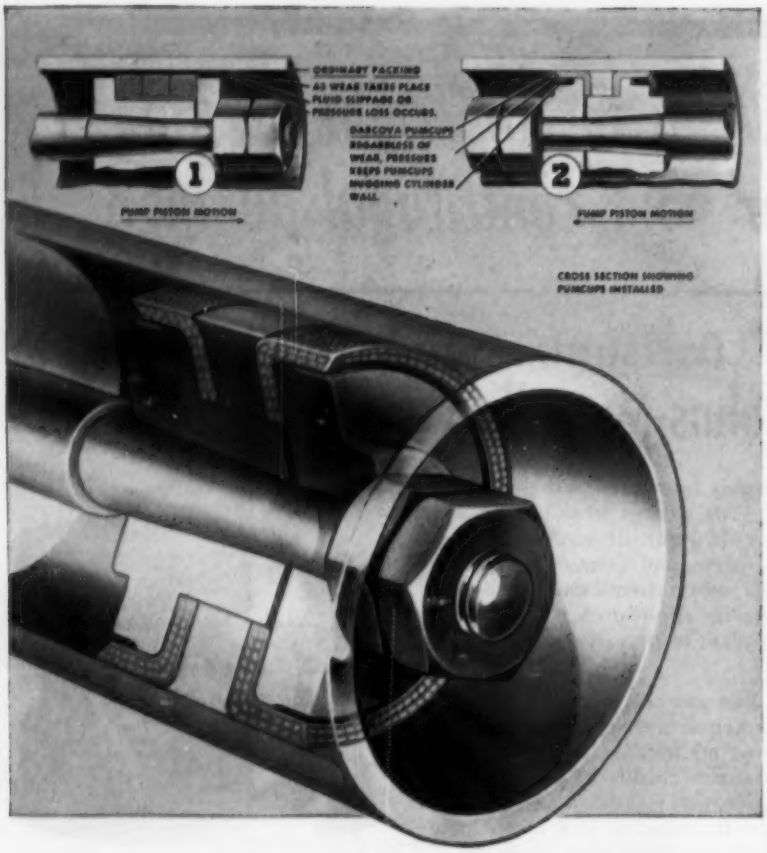
The exact composition of these packings varies according to the service conditions for which each particular style is designed. As an example, one of these, Style No. 610 is an excellent general maintenance packing for service against steam, air, ammonia, gases, etc. up to 550F. It is made of selected asbestos fiber mixed with pure graphite and a small amount of non-friction metal, then bonded with a heat-resisting compound to form a pliable coil or spiral. It is furnished in sizes of $^{1}/_{8}$" and up.

YOUR J-M PACKING DISTRIBUTOR will gladly recommend the right packing for your equipment, and furnish it from stock for your immediate requirements. Write Johns-Manville, Box 60, New York 16, N. Y. for his name and address. In Canada, 199 Bay St., Toronto 1, Ontario.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville PACKINGS and GASKETS

Circle 518 on Reply Card for more data



DARCOVA PUMCUPS mean EFFICIENCY to cost-minded engineers!

IN air and hydraulic cylinders and reciprocating pumps Darcova Pumcups actually retain full efficiency *throughout* their life span . . . and they outlast most other packings at least 3 to 1!

Special texture engineering plus the Darcova Pumcup principle makes it possible for Pumcups to hold their peak volumetric efficiency. Moreover, Pumcups permit equipment to be operated at reduced speeds, save power, prolong equipment life and eliminate the need for frequent replacement shutdowns.

For less maintenance and lower operating costs find out more about Darcova Pumcups. Write for Bulletin No. 4502 on Pumcups for air or hydraulic mechanisms, Bulletin No. 4401 on Pumcups for reciprocating pumps.

DARLING VALVE & MANUFACTURING CO.
Williamsport 9, Pa.

DARCOVA
THE ORIGINAL COMPOSITION CUP
PUMCUPS

Circle 519 on Reply Card for more data

new bulletins

—*Starts on page 28*

made and includes the newer varieties. Case histories show successful use of Subox paints on various types of industrial equipment. Subox, Inc.

222—Heavy-duty Air Cylinders

Up-to-date design and construction, engineering, and mounting data on Miller 200 psi heavy-duty air cylinders are given in Bulletin A-105K. Cylinder sizes range from 1½- through 14-in. bores in strokes up through 22 feet in 17 standard mounting styles. Eight pages. Miller Fluid Power Co.

223—Cost of Chemical Coatings

Selection of any protective coating system should be primarily based on cost per square foot per year of service, according to Bulletin 600. It describes the Phenoline Series coatings which are modified phenolics for use as tank linings, severe maintenance painting, and floor coverings in acid, alkali and solvent environments. Corrosion charts will be sent with the bulletin. Four pages. Carboline Co.

224—Inside Information on Injection

"Six Money Saving Facts About Caterpillar Fuel Injection Equipment," explains what is behind the production and design of efficient fuel injection equipment. Booklet DE580 discusses interchangeability of parts, ease of maintenance, and ability to burn non-premium fuels. Eight pages. Caterpillar Tractor Co.

225—Pulley Gives Variable Speed

Hi-Lo automatic variable speed pulleys and Hi-Lo systems are described in a new booklet. It is illustrated with graphs, diagrams, cut-away views, and photos of the unit in action. Specifications are given on three available bases. Eight pages. Equipment Engineering Co.

226—New Centrifugal Fans

Recently redesigned and expanded line of utility fans—both belt-driven and direct-driven centrifugal—are described in Bulletin DS-348U. Fan selection data include capacity tables for all sizes and types, roughing-in dimensions, and mechanical specifications. Twenty-four pages. The Trane Co.

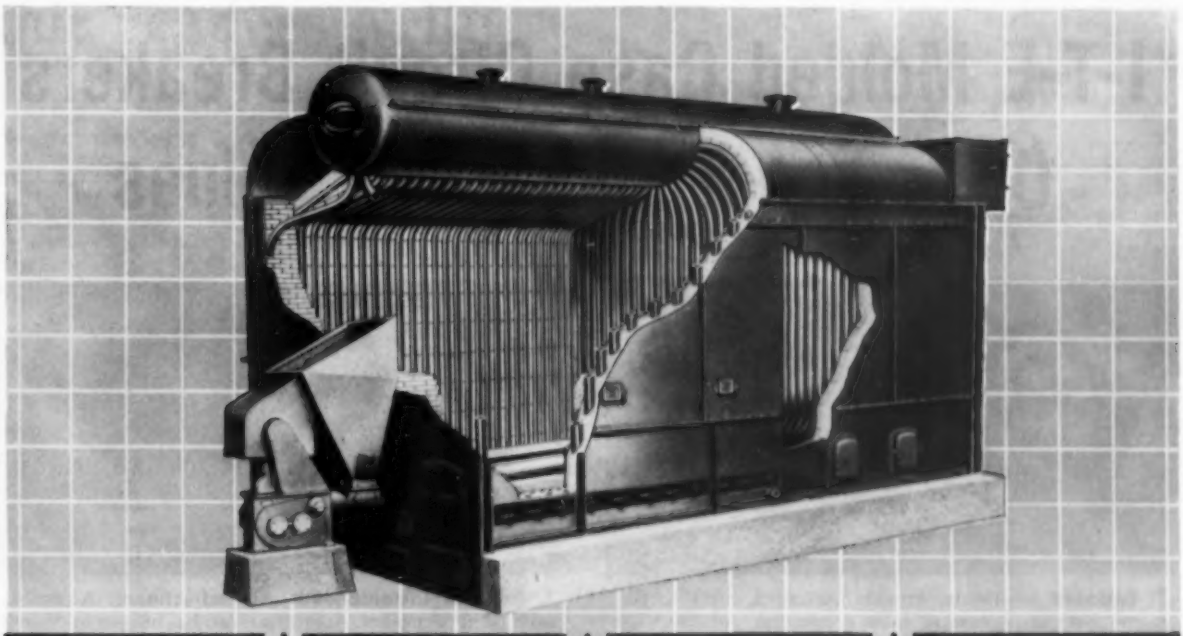
227—Stop Steam Contamination

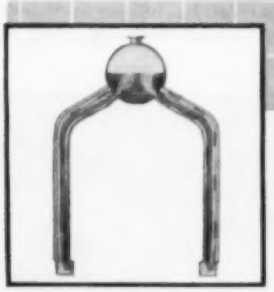
Steam contamination and how to prevent or correct it is outlined in "Steam Purity." Various types of carryover are discussed along with the value of antifoams in stopping carryover. Six pages. Hall Laboratories, Inc.

228—Compressor Construction Data

"Air Compressors for Industry," Bulletin A-62, presents a graphic analysis of the WN-112 compressor—including discussion of construction, lubrication, and regulation. Thirty-two pages. Joy Mfg. Co.

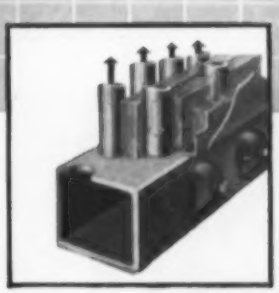
(More bulletins on page 76)



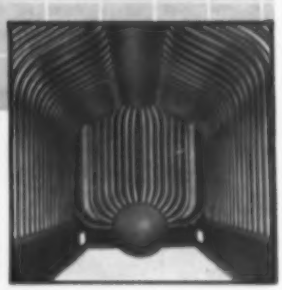


RING-FLOW CIRCULATION IN EACH WATER WALL ELEMENT

POSITIVE WATER SUPPLY TO WATER WALLS



WATER WALLS ACCESSIBLE FROM OUTSIDE THE SETTING



LOW FURNACE ROOF PROTECTS BOILER TUBES

Exclusive
ERIE CITY DESIGNS

The **VL** factory assembled or field erected, has EXCLUSIVE features that assure minimum furnace maintenance and a positive supply of clean water to the water walls. These EXCLUSIVE features are the result of many years of experience in designing and building two drum boilers; thousands of which are operating in the field today, giving users the satisfactory service they demand.

WE PAY ROYALTIES TO NO ONE FOR THESE DESIGNS

ERIE CITY
113 Years in Steam Generating

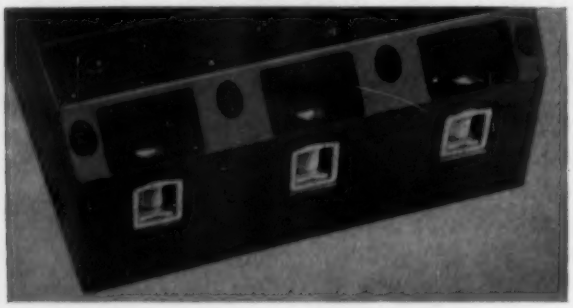
You can depend on Erie City for sound engineering

ERIE CITY IRON WORKS • *Erie, Pa.*

STEAM GENERATORS • SUPERHEATERS • ECONOMIZERS • AIR PREHEATERS
UNDERFEED AND SPREADER STOKERS • PULVERIZERS

Circle 520 on Reply Card for more data

I-T-E Molded Case Circuit Breakers Offer You These Extra Values



1. Enclosed terminals. Provide maximum safety to personnel, yet permit ease of cable connection. All 600 v a-c rated I-T-E molded case breakers have enclosed line and load terminals.

2. External instantaneous trip adjustment. Accessible from front of breaker. Adjustment can be changed to desired setting after breaker is installed without removing cover or disrupting service.

3. Greater terminal clearance. I-T-E molded case breakers are designed on multiple 1½" pole centers to provide maximum phase to phase spacings and reduce electrical leakage clearance problems.

4. Plug in mounting. I-T-E molded case breakers can be readily equipped with tulip clip adaptors and molded mounting block for maximum flexibility when changing and installing breakers.

5. A complete line. I-T-E manufactures a complete line of commercial, Navy and maritime molded case circuit breakers 10 through 600 amp, 600 v a-c, 250 v d-c. All are available with various special features and in all types of individual enclosures.

Contact your I-T-E representative or authorized distributor for the Speedfax Catalog—containing complete information on all I-T-E circuit breakers and enclosures. Or, if more convenient, write Small Air Circuit Breaker Division, I-T-E Circuit Breaker Company, 19th and Hamilton Streets, Philadelphia 30, Pa.

I-T-E CIRCUIT BREAKER COMPANY

Small Air Circuit Breaker Division

Circle 521 on Reply Card for more data

our readers write

. . . to industry & power

New Variable Speed Drives

Gentlemen:

We have read the article in your March issue concerning new drives for variable speeds. We would particularly like to get catalogs describing in further detail the Graham device. . . . The Specone. . . . and the Lombard Governor Company's device.

Russell H. Kent
The Kent Manufacturing Co.

• *Write to Graham Transmissions, Inc., Menomonee Falls, Wis.; Speed Control Division, Fairchild Engine and Airplane Corp., 90 Riberia Street, St. Augustine, Fla.; and Lombard Governor Corporation, Ashland, Miss.*

Grouting for Virginia

Gentlemen:

I want to obtain the details of a process described in the September 1954 issue of your excellent publication. The delay in writing for this information results from having loaned the September issue soon after receiving it and not being able to retrieve it until yesterday.

The method of controlling water seepage described by Mr. John P. Graedinger in the article "New Chemical Grouting Method Prevents Flooded Floors," appears to be a solution. . . . to similar problems in the Shipyard and elsewhere in this low-elevation, high-water-table area. . . . I do not know how to contact the author or the supplier of the materials used. For this reason I am addressing this letter to you with the request that you forward the enclosed copy to the persons who can furnish complete information.

Clinton H. Smoke
Electrical Engineer
Norfolk Naval Shipyard

• *Mr. Smoke's letter has been forwarded to Mr. Graedinger.*

Address Known

Gentlemen:

Just read the article "Solving the Flyash Problem" at the Homer-Laughlin China Company in Newell, West Virginia. Every once in a while we install flyash collectors and for that reason would like to have the address of the Breslove Separator Company so I can write them for literature and other descriptive matter. . . . Will you please handle this any way you see best?

H. Schwendener
Pet Milk Company

• *Breslove Separator Company is located in the Commonwealth Building, Pittsburgh 22, Pa.*

Concerning Rust Inhibitors

Dear Sir:

We are much interested in the report concerning volatile rust inhibitors mentioned on page six of the March 1955 issue. . . . Since we have experimented to some extent with such materials, it will be appreciated if you will advise as to the exact description or identification number of the Naval Research Laboratory's report so that we may obtain a copy.

G. M. Cresson
Engineering and
Manufacturing Division
International Standard Electric
Corporation

• *Order Bulletin No. PB111407 from Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. The price is $1.00.*

Pick INSTANTANEOUS HOT WATER HEATERS
ENGINEERED FOR SERVICE

Industries everywhere are replacing outmoded water heaters with Pick Instantaneous Water Heaters. Here are the reasons:

★ **Water Is Heated Instantly.** Entirely automatic, Pick Heaters operate by steam injection to heat the water in a flash to exact temperature desired and in volume required.

★ **Fuel Savings Are Substantial.** Steam injection heating is the most efficient method known. There's no waste because water is heated only as used . . . never stored and allowed to cool.

★ **No Storage Tanks Required.** Compact design of Pick Heaters permits out-of-the-way installation in corners, on walls or overhead. Saves valuable floor space.

★ **Exact Temperature Control.** Pick heaters can be operated at low or high loads with minimum temperature fluctuation. And it's done quietly.

★ **Maintenance Cost Is Low.** Pick Heaters can be cleaned in a matter of minutes — worn parts easily replaced.

★ **Installation Is Inexpensive.** Only ordinary pipe connections are required.

PICK HOT WATER HEATERS . . . Used by
• United States Steel Co.
• Ford Motor Co.
• H. J. Heinz
• Bethlehem Steel Corp.
• Hercules Powder
• Wilson & Co.
and MANY OTHERS

SAVES MONEY FOR ANY INDUSTRY THAT USES HOT WATER!

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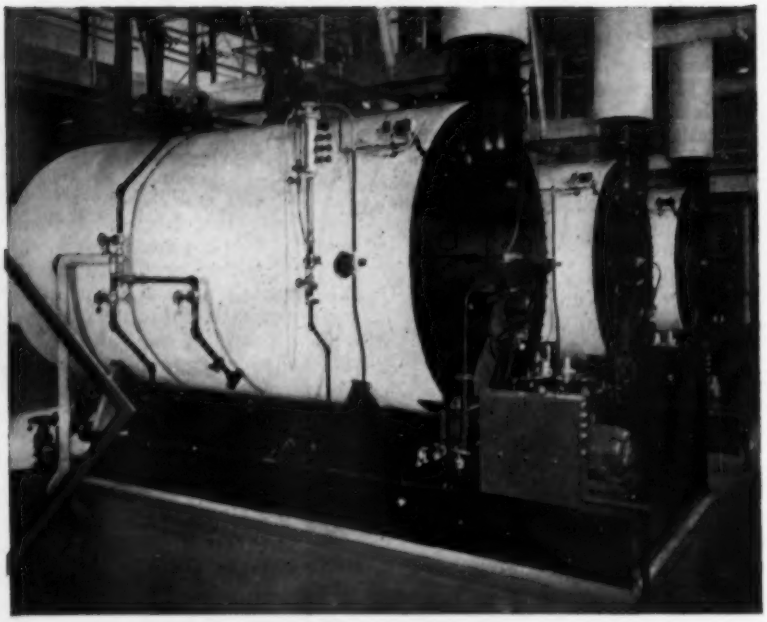

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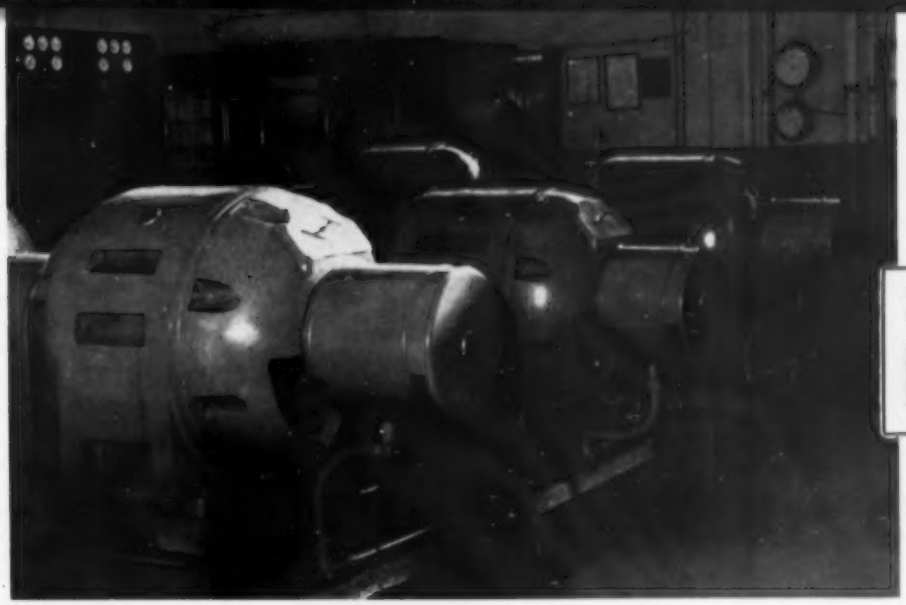


Three motor-generator sets produce power at 340, 420, and 540 cps to drive grinders.

Industry and I&P Power

I&P EXCLUSIVE

Hyatt Bearings Division Enjoys

Versatility in High-Frequency Power

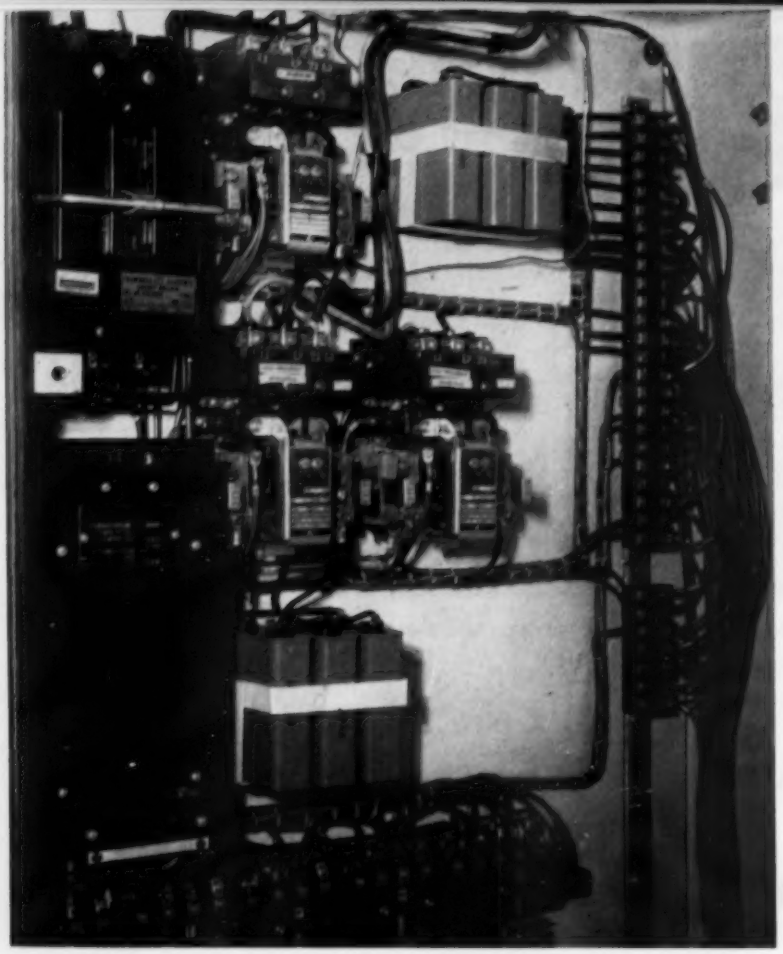
H. A. BERGEN, Editor

ELECTRIC POWER service is neatly tailored to the needs of production in the Rahway, N. J., plant of Hyatt Bearings Division (General Motors). At the same time, it is flexible and versatile. Power is supplied at 60, 340, 420, and 540 cps. The 60-cps power is used for conventional plant loads. But the high-frequency power, in combination with two- and four-pole motors, offers a wide choice of compact, lightweight, high-speed drives to the production people. Any of the following motor shaft speeds is available through proper combination of frequency and motor: 10,000, 12,500, 16,500, 25,000, and 33,000 rpm. The motors range in rating from two to nine hp.

These motors are employed in grinding operations. The motor shafts are used as spindles to carry the grinding heads. Because motors driven at these high frequencies pack a great deal of power into a small frame, the entire motor-and-grinder spindle assembly is extremely light in pounds-per-horsepower weight. The motor-grinder assembly can be easily and rapidly reciprocated along the motor shaft axis because the mass and inertia forces involved are quite small. Thus, the rotation of the motor shaft is combined with lateral motion along the shaft axis in an ideal grinding operation.

The high-frequency power is generated by three motor-generator sets, one set for each frequency. Conventional low-loss feeder duct brings 60-cps power to the generator room. The high-frequency power from each of the mg sets is sent out to the plant via specially modified

Fused tap-offs feed machine cords. Note extra cord wound above bus.



Reactive effect of capacitors is greater at higher frequencies, so power factor correction capacitors are small enough to go inside control boxes.

feeder duct. An aluminum shell replaces one half of the expanded steel mesh that ordinarily wraps around the conventional feeder duct. The aluminum breaks up the magnetic flux that would flow through the expanded steel mesh if that magnetic path was not interrupted by the aluminum. This modification reduces magnetic losses that otherwise would be intolerable at the high frequencies.

Synchronous Drives

Synchronous motors drive the generators on the mg sets. They are operated at 0.80 leading power factor for system power factor improvement. Each mg set is rated 150 kva. The 340-cps generator is rated 150 kva and 204 volts at 1200 rpm. The 420-cps generator is rated 150 kva and 255 volts at 1800 rpm. The 540-cps generator is rated 150 kva at 330 volts and 1800 rpm.

Circuit breaker takeoffs are spotted on the high-frequency feeder duct as it runs through the plant. The breakers feed plug-in bus duct through flexible conduit. The flexible conduit insures versatility. Any run of plug-in duct can be fed from any high-frequency feeder via the flexible conduit.

Use Fused Taps

Fused taps in the plug-in bus duct feed each machine through a drop cord. Drop cord lengths are stand-

Conduit is fed via junction box from flexible conduit. Pull cords on breakers permit control from floor.

Little water-jacketed motor packs as much as 7½ hp at high frequencies. It reciprocates while its shaft turns.

ardized at 40 feet. Each cord runs up vertically from its machine to a spring-loaded cable bend. The cord then runs horizontally to the bus duct line. The excess cord is wrapped around vertical fingers on the bus duct. Loops of excess cable do not hang in midair.

All the high-frequency powered production tools are fed from the plug-in duct, again insuring flexibility. Power factor correction capacitors are housed inside of the control cabinet for each machine. Because of the high power frequency, the capacitors can be unusually small. They are switched on and off as their respective machines are switched on and off. This eliminates the possibility of overcorrection on the plant system during hours when the plant is not in full production.

Swap Losses

It is acknowledged that the distribution system losses are greater at these higher frequencies than they would be at 60 cps. The increased losses are chiefly due to the fact that magnetic losses and the crowding effects of skin effect increase as frequency goes up. But this does not tell the entire story. These losses in the distribution system are more than made up by the losses eliminated in what otherwise would have to be conventional gear or belt mechanical drives.

Without high-frequency power, any grinding head speeds over 3600 rpm would have to be obtained through the use of gear or belt drives. Gear drives would not be fast enough nor lightweight enough to perform the high-speed grinding in combination with the reciprocating motion. The slippage losses in belt drives at the high speeds would be excessive.

Feasible Above 15,000 rpm

Hyatt's experience shows that high-frequency power becomes feasible when the speed required exceeds the basic motor speed by more than three or four to one. Thus, 60 cps power limits grinding head speeds to 12,000 or 15,000 rpm. Beyond these speeds, slippage becomes a serious problem. The efficiency of the drive falls off. The excessive slippage also causes belt life to fall off and downtime to go up. The high costs of belting, downtime, and maintenance labor are the factors that outweigh whatever additional costs might be attributable to those losses in the electrical distribution system that are due to the high frequencies. (There are additional advantages to the high-frequency power in that the low mass of the grinding units permits fast reciprocation and, thus, faster production.)

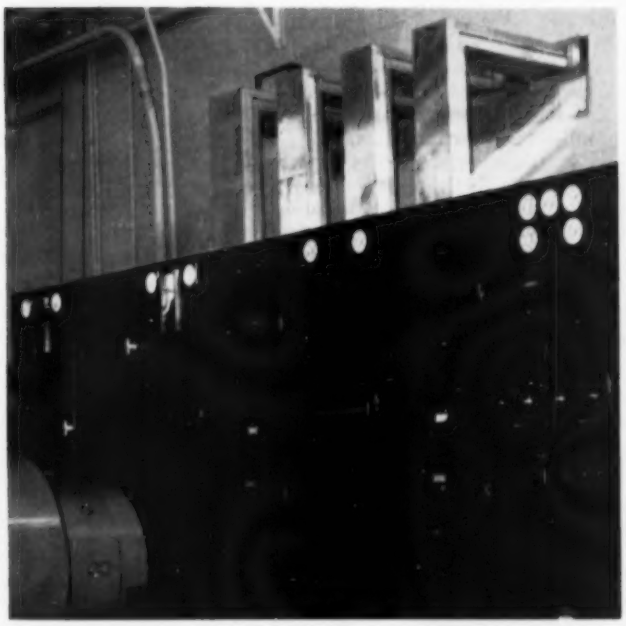
Because of the increased losses at the higher frequencies, breakers and bus duct are derated some 20 to 30 percent from 60-cps ratings. In order to keep a stock of standard parts without excessive inventory, however, Hyatt decided to use 400 ampere bus duct. The plug-in duct, therefore, actually is loaded only to some 40 percent of its 60-cps rating, even though the derating studies determined that the derating from 60-cps values need be only 20 to 30 percent.

Though the inductive losses are greater at the higher frequencies, capacitive reactance is increased at the higher frequencies so that the power factor correction capacitors can be smaller than they would have to be at 60 cps for creation of a given amount of leading vars.

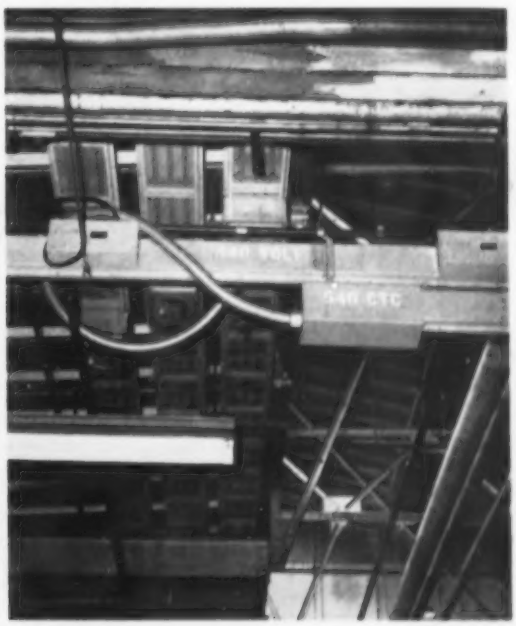
Cool With Water

To help keep the motor size down, the motors are cooled by water circulated through jackets that are an integral part of the motor housing. This could give rise to a tough maintenance problem — keeping the motor windings dry. But in almost a year of operation, maintenance of the cooling water system has proved to be no problem.

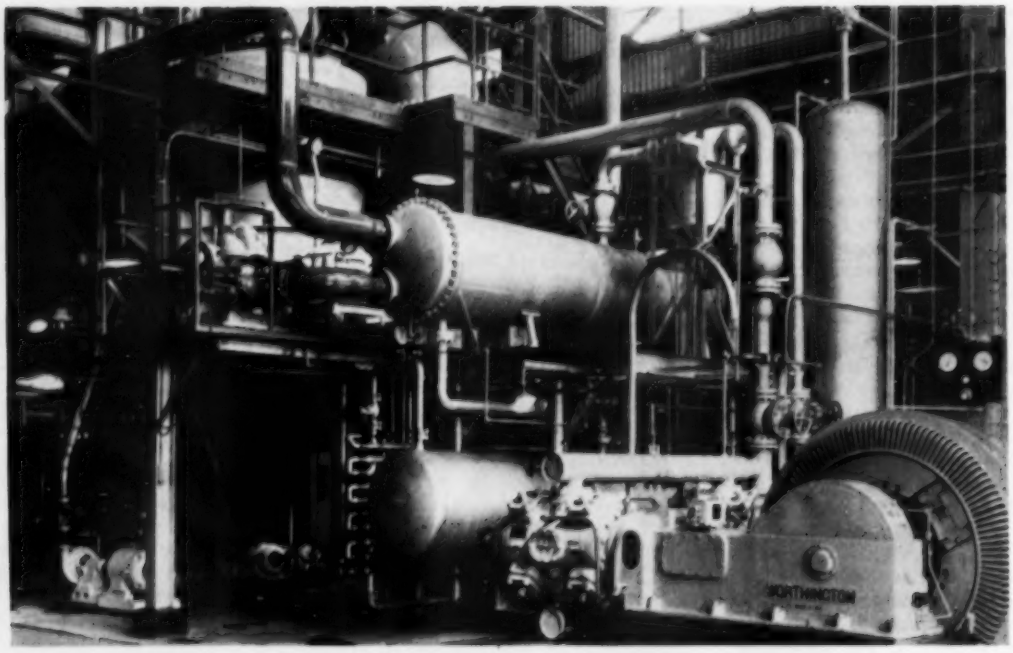
The normal course of progress dictates that any given machine will be moved from one location to another within the course of a few years. The high-frequency electrical distribution system at Hyatt Bearings Division demonstrates that electric power distribution can be tailor-made and still be flexible.



Power at 60 cps enters mg room via feeder duct at far left. High-frequency power leaves in aluminum-covered feeder ducts.



Power of any frequency can be fed to plug-in duct by quickly reconnecting flexible conduit.



Compressor and condensers in a Florida refrigeration plant. High condensing pressures reduce efficiencies.

Care and Operation of

Refrigerating Plant Condensers

I&P EXCLUSIVE

C. T. BAKER
Consulting Engineer

OF THE VARIOUS components of a refrigerating plant, the one most likely to be neglected is the condenser. Then too, the condenser is not always installed so as to ensure efficient performance.

The purchaser has the choice of a number of types of refrigerating condensers. While no one particular type can be considered best for every situation because circumstances affect performance, all modern condensers will operate satisfactorily when correctly matched to the conditions for which they were designed and when they are given adequate maintenance.

Types in General Use

Where ammonia is employed as the primary refrigerant, horizontal multi-pass, vertical single-pass, and evaporative type condensers are widely used. Double pipe condensers with the cooling water flowing in the inside pipe and the refrigerant flowing in the annulus between the two pipes are used to some extent. Where the refrigerant is of the Freon group, the horizontal multi-pass and the evaporative type are most commonly used although some small capacity Freon units use the air cooled type of condenser.

Function of the Condenser

The function of the condenser, in refrigeration, is to remove both the sensible and the latent heat from the superheated gas as it enters from the compressor, and to reduce gas temperature to a point where it will condense to a liquid. Heat from the superheated gas is released to the water flowing through the tubes, or, in the case of the evaporative condenser, to the water that evaporates from the surfaces of the tube bank and is exhausted from the unit by fan supplied air.

Efficient operation of any type of condenser depends upon a number of factors:

¶ Adequate supply of condensing water.

¶ Proper drainage of liquid from condenser to receiver.

¶ Location of condensers in a well ventilated spot, protected from the heating effect of the direct rays of the sun.

¶ Tubes must be kept free of dirt, scale, and algae deposits.

¶ The system must be kept free of air or other non-condensable gases.

¶ Condensing water must be evenly distributed to all condenser stands or units.

¶ Provision of a vent from the top of the liquid receiver to the highest point on the condenser.

¶ If more than one stand of condensers is used, provision of a gas pressure equalizing line to interconnect the gas inlet connections from each condenser.

¶ Provision of thermometers on the condensing water inlet and outlet

headers so that temperature increase or range can be determined easily at all times.

Water Supply—Quantity Required

The general rule for determining the amount of water that should be supplied to ammonia refrigeration condensers (other than the evaporative type) is to allow 5 gpm per ton of refrigeration where cooling towers are used for cooling the condensing water before reuse, and about 3 gpm where water supply is taken from wells, lakes, and rivers. Of course, there are exceptions to this rule. For instance, if the water is high in minerals that could be deposited on the condenser surfaces, then it is much better to supply larger quantities of water in order to hold the temperature rise to 5 or 6 degrees. This also ensures lower condensing pressures since 3 gpm per ton of refrigeration is based on a 10 degree rise in temperature of the water in the condenser, while 5 gpm is based on a rise of 6 degrees. Freon refrigerant systems require less water.

There is, of course, a practical limit beyond which it does not pay to increase the water supply to the condenser, as the cost of pumping excess quantities of condensing water offsets the gains made by reducing the power required to drive the compressor.

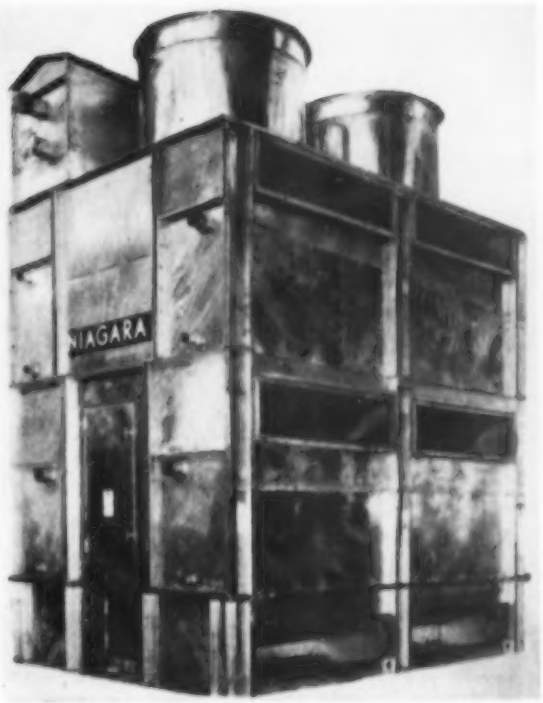
Cooling Range

Cooling range of the water passing through the condenser is defined as the difference between the temperature of the cold water entering and that of the warm water leaving.

A ton of refrigeration is equal to 200 Btu per minute (12,000 Btu per hour). That is the rate at which heat is taken up from some temperature level higher than the evaporating temperature of a primary refrigerant. A compressor does work on the gas in raising its pressure from, say 20 psig to 185 psig. This work is reflected in an increased gas temperature and in the total heat content of the gas. This adds about 50 Btu per minute per net ton of refrigeration, for all ordinary refrigerating plant operations, meaning that the condenser must dissipate 250 Btu per ton of refrigeration (gross) and must, therefore, be designed to handle such an amount of heat.

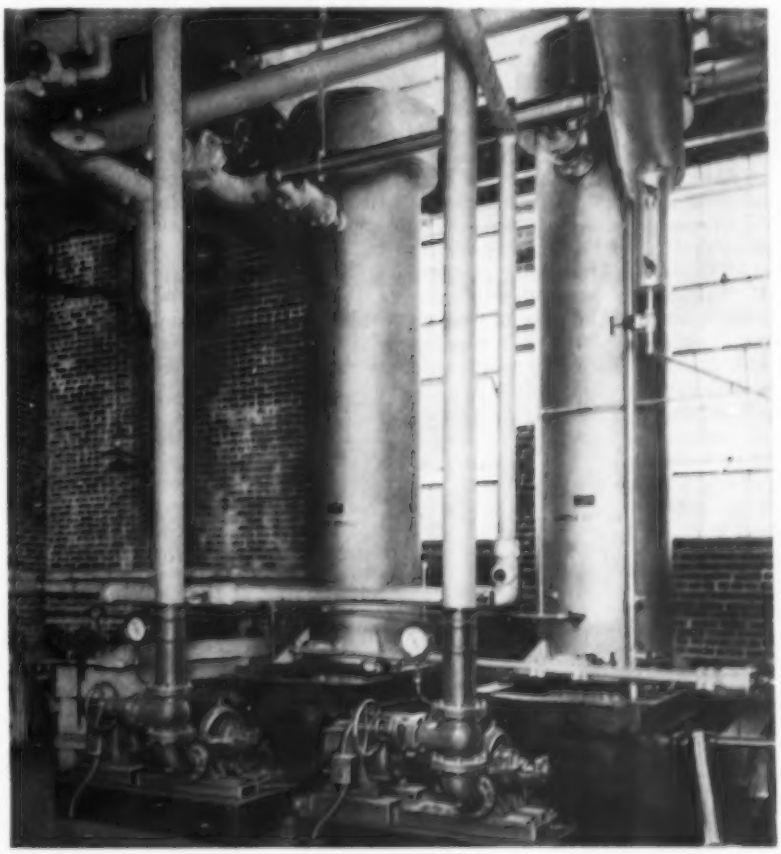
High Condensing Pressures

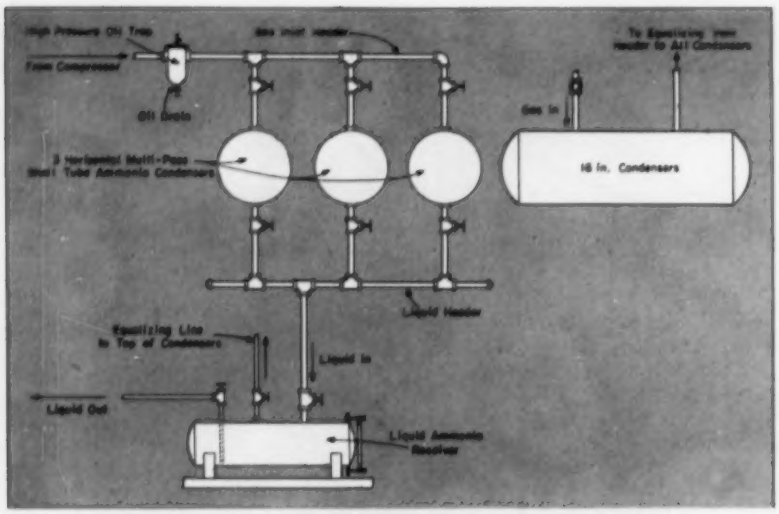
It is important that condensing pressures be held within limits determined by the quantity and temperature of the condensing water used. High condensing pressures not only increase power costs, but re-



A compact 200-ton capacity evaporative condenser.

Vertical type condensers are widely used where floor space is at a premium.





Drawing shows hook-up of horizontal condensers and arrangement of vents.

duce plant capacity. Tests have shown that for every 5 pounds excess condensing pressure there is an increase of 2 percent in power costs and a decrease of approximately 1 percent in over-all plant capacity.

Flash Gas Reduces Efficiency

Flash gas produced in the expansion valve or other pressure reducing device does no useful work but it must be handled by the compressors and the condenser like the gas that results from the boiling of liquid refrigerant in the evaporator. Therefore, large amounts of flash gas reduce the net capacity. The amount of flash gas developed when high temperature liquid must be cooled to the temperature of the evaporator is considerable. With a suction pressure of 15 psig and a condensing pressure of 150 psig the percentage of ammonia evaporated on passing through the expansion valve is 16.7 whereas with the same suction pressure and a condensing pressure of 190 psig the percentage of ammonia evaporated on passing through the expansion valve increases to 19.4. This gas, in passing through the evaporator, retards normal evaporating processes and tends to produce sluggish performance of the evaporator. This is particularly true with coil type condensers.

There are generally four factors that increase condensing pressure:

¶ Insufficient condensing water
¶ High temperature gases
¶ Dirty condensers
¶ Non-condensable gases in system.

Of the four reasons named, the last two are the more common.

At regular intervals a careful check should be made to determine the condition of the water surfaces of the condenser tubes. Tubes should be cleaned often enough to prevent excess accumulations of dirt, scale, and algae. Deposits on the water surfaces of tubes or on the coils of evaporative condensers act as insulation and cause poor heat transfer from the refrigerant to the water.

Non-condensable gases in the system can be held to a minimum by the use of a non-condensable gas purger which is effective with either ammonia or Freon refrigerants. Most of the non-condensable gas in a refrigerating system is air that enters around compressor shafts or rods, or when a pipe line or coil is not completely evacuated after having been out of service for repairs.

Test for Air

In an ammonia plant where an air purger is not used and there is a suspicion of air present in the system, the following test will be found a very safe guide.

Suppose that the temperature of the condensing water is 72.6 F. The system is partially or completely emptied and the compressor is stopped. Condensing water is allowed to flow over or through the condenser until the unit has cooled to the temperature of the water. The high pressure gauge then shows that the pressure on the system is, say, 180 pounds. Reference to the table of "The Properties of Saturated Ammonia" shows that the pressure corresponding to 72.6 degrees is 120 pounds. This is what an accurate gauge would register if the system were free of air. The difference between 180 and 120 pounds pressure is the direct result of non-condensable gases present in the system.

In some instances, a check valve is located on the discharge line between the condenser and the compressor. In making the test, it is important that the check valve be raised to its highest position by hand so that the pressure gauge will indicate the pressure at the condenser. Otherwise, when the compressor stops and the check valve closes, the pressure between it and the gauge would be less than that actually on the condenser.

Leaving Temperatures

A thermometer on the liquid outlet of the condenser will indicate the leaving temperature of the ammonia, and if the system is free of air, the pressure shown by a gauge placed near the thermometer will correspond to the temperature of the liquid ammonia passing from the condenser.

In the interest of both power costs and plant out-put, it is quite important that the condensing pressure be kept as low as conditions permit.

It sometimes happens that an insufficient amount of condenser capacity is installed. Resulting condensing pressures will be high and a careful check of compressor output during times of maximum demands against condenser capacity should be made.

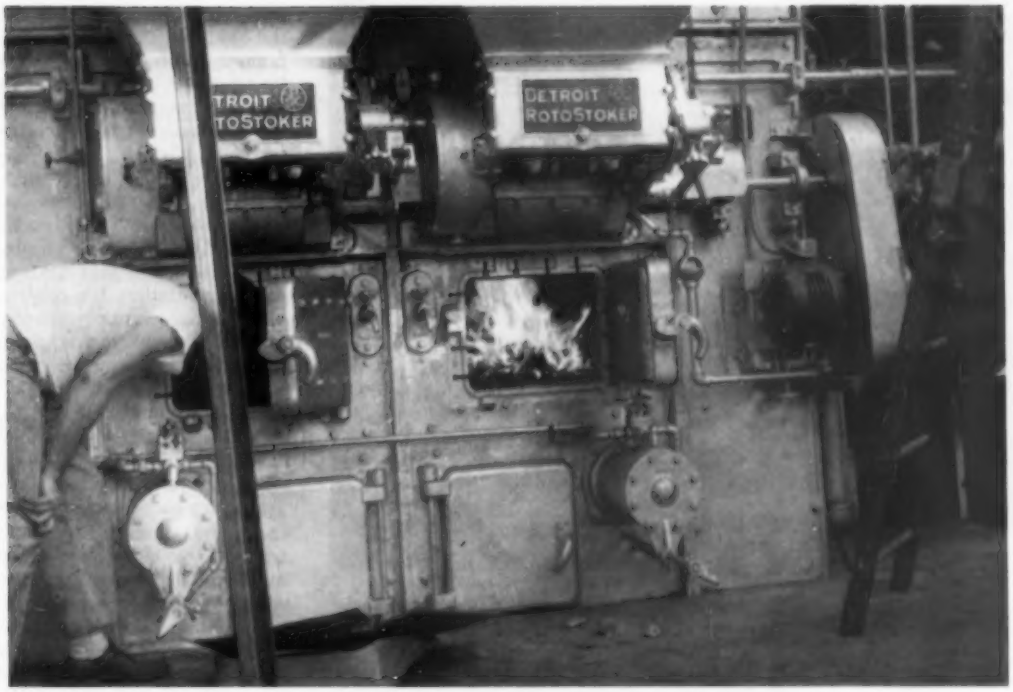
Equalizing Connections

It is important that all condenser stands be connected at the top with an equalizing line of ample diameter, to ensure equal inlet pressures on all stands. Where more than one inlet header is used to connect two or more groups of condensers, the water inlet and outlet headers should be interconnected.

It is essential that the liquid receiver be properly vented back to the condenser. Otherwise, if the receiver is located in a warm place, gas will form above the surface of the liquid causing receiver pressure to somewhat exceed that of the condenser, thus retarding the free flow of liquid from the condenser to the receiver. This, in turn, will cause an increase in condensing pressure.

Position of Valves

The shut-off valves on the liquid line between the liquid outlet header and the receiver, as well as the valves on the liquid line of the individual condensers should be placed in a horizontal position. When placed in a vertical position, gas forms in the valve openings, causing excess pressure at those points, retarding liquid flow to the receiver, and increasing condensing pressures.



The schedule for trial runs must be timed so that the stoker is tested before the controls are operated.

Selecting Fuel and Firing Equipment

Coal was the fuel selected for this efficient 250 hp packaged outdoor water-tube boiler.

D. W. KARGER

Chief Plant and Industrial Engineer

The Magnavox Company

I&P EXCLUSIVE

THE SELECTION of the type of fuel to be used in the new outdoor packaged boiler installation at our Fort Wayne plant was relatively simple, once we had decided upon which size and type of boiler to install. While some natural gas is piped into our area, the amount available is limited and a continuous winter supply could not be guaranteed. Fuel oil is delivered to Fort Wayne by tank car or truck, and is therefore relatively expensive. This eliminated two of the most desirable types of fuel to use.

The remaining common fuel is, of course, coal. It could be obtained at a relatively low cost from nearby Indiana mines. The only problem remaining, was to determine what type of firing equipment should be used to obtain maximum efficiency. There we called upon our consulting engineers and the boiler manufacturers. We reached a joint conclusion on the type of stoker equipment to use, and they also supplied the names of some reliable manufacturers of this type of equipment.

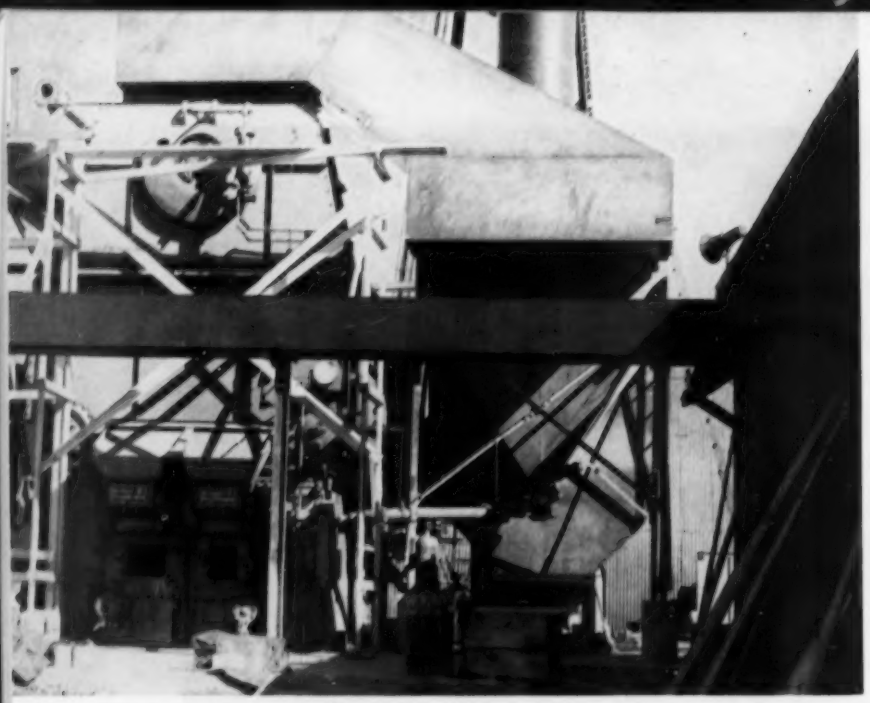
Before making our selection, we visited actual installations of our boiler manufacturer's equipment and noted operating experience in the various plants visited. The final selection of the manufacturer was made by us.

We decided to use a spreader stoker, which, with satisfactory instrumentation, gives a relatively high operating efficiency at the loads under consideration without depending too much upon the knowledge and technique of the firemen. This was a point of major importance in our particular installation.

Various types of grates can be purchased with spreader stokers. There are four basic types; stationary, manual dumping, power dumping (by either air or steam) and traveling grates.

Traveling grates are the most desirable since they provide a relatively constant fuel bed with only minor variations in thickness. The traveling grate also provides for dumping the ash at one location, which in turn simplifies ash disposal. They are quite expensive, however, and we chose a less expensive type of stoker grate.

We chose power dumping grates using compressed air (since air was available near the boiler site). Steam can also be used for this purpose, and is quite satisfactory. We had, however, another reason for powering the grates with air. If steam were used, power for dumping would be available only when steam was up in



Fly ash collector and reinjection system shown at right of boiler increase efficiency and simplify fly ash handling as the ash is mostly melted to slag.

the boiler. Air was always available.

Grate design is of prime importance. Air flowing through them must be uniform, and the air orifices must be so designed that they do not readily plug up. If they do plug, clinkering will occur and the boiler must be taken out of service to free the orifices. Warping is also a very undesirable feature. These items were carefully checked on operating installations during our visits to other plants.

Another item of prime importance in the eventual selection of a stoker is the caliber of the stoker manufacturer's representatives in your area. You must work closely with the stoker manufacturer on the foundation, brickwork, instrumentation, equipment installation, load range to be handled, the type of coal to be fired, spare parts to be carried, initial starting, and efficiency tests of the boiler. It is important, therefore, that the stoker manufacturer's representative be readily available.

Maker Supplies Drawings

The stoker manufacturer will supply erection drawings and, in addition, erection supervision is generally supplied. In fact, the entire job can usually be contracted with the stoker manufacturer. We supplied the actual erection labor and so gained the additional experience of knowing how the unit went together and what difficulties were going to be encountered in making repairs and adjustments. We did use their erection engineering service, which we are happy to say was both adequate and competent.

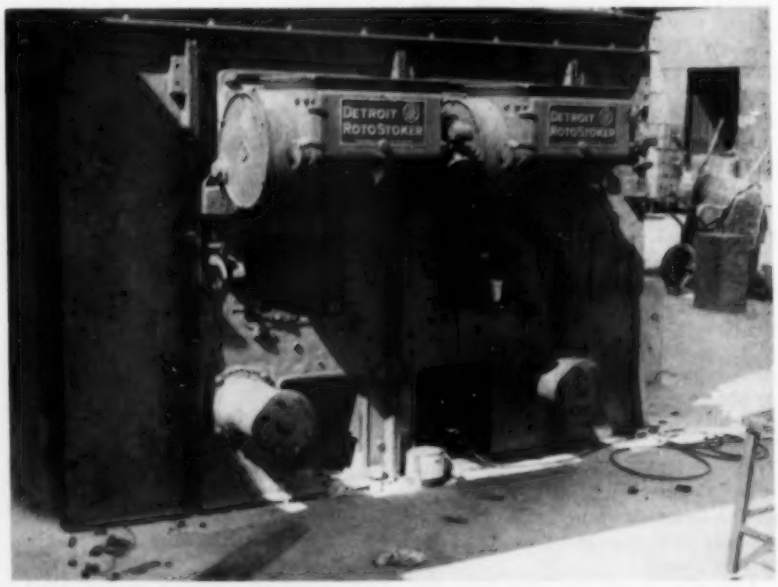
A minor point to be considered was the welded coal hopper installed on top of the stoker. It is well to inform the stoker manufacturer beforehand as to what is required in this respect, and either buy it directly from him or at least afford him the opportunity of building in any necessary bracing required to carry the load imposed on top of the stoker hopper itself. The size of the auxiliary hopper is to some extent dependent upon the type of coal feeding mechanism used.

Schedule the Trials

Before starting up the boiler, the stoker company's field engineering service should be in the plant for a few days, and if you have made the basic installation, the control equipment representative should follow him to "debug" the equipment and put it into proper operation. Otherwise, if the control system is installed by the manufacturer, his representative's visit should be scheduled so that the controls will be ready to work a few days after the stoker. This delay can occur since the stoker can, and should, be successfully hand operated before complicating the issue by working the automatic control system.

Be sure to inform the stoker manufacturer's field engineer of the specific type of control system used, its specific functioning, and what it will and will not do. Unless you are well experienced in the steam generation field, find out exactly how it operates and how to set the stoker in relation to the control system for maximum efficiency.

The actual selection of the firing equipment must follow very quickly after selecting the boiler size and type since the foundation and erection drawings are greatly affect-



Erection can be done by the manufacturer, but the knowledge gained about the details of construction make it worthwhile to use your own labor.

ed by the firing equipment manufacturer's requirements.

With a spreader stoker a considerable amount of fly ash is a natural occurrence. This fly ash consists of true ash and some unburned material. To get maximum efficiency and simplify the handling of all ash, including the fly ash, a fly ash re-injection system is required.

This system is usually supplied by the maker of the spreader stoker. Installation drawings were supplied by the maker of the fly ash re-injection system, and installation was done by our maintenance force. The re-injection system collects the fly ash from the side hoppers of the boiler, the fly ash collector, and if desired, from the bottom of the stack, and reinjects it into the firebox proper. The combustible material is thereby burned to yield additional heat and much of the re-injected ash itself is melted into slag, which under normal conditions is easier to handle than the fly ash itself.

Stack and Induced Draft Fans

Our existing stack was inadequate to handle both the new boiler and the old boilers that we must use for high loads. In order to keep stack costs to a minimum and also to provide a better and more constant draft, an induced draft fan was installed.

The boiler manufacturer's local field representatives worked with us very closely in developing the required size of stack and induced draft fan, assisting us to the extent of making over-all layout drawings. The stack itself was constructed and installed by a local firm who also supplied the breeching and other required duct work.

It should be mentioned that the clean-out door on our stack originally leaked a certain amount of soot which in turn blew over the yard. It is important that this door be gasketed in a manner to prevent this nuisance. The soot can be re-injected and some heat recovered if a re-injection fly ash system is provided.

The induced draft fan was purchased with water cooled bearings and as yet it has been trouble-free. We have had no difficulty from freezing of the cooling water, as the coolant piping to the bearings runs parallel to and touching one of the boiler mud drums.

Fly Ash Collector

Although our city has no significant smoke ordinance, we felt it advisable to provide a fly ash collector for the following reasons:

¶ With a short stubby stack it was obvious that any great amount of fly ash would blow into the plant whenever the wind was in the right direction. Our plant operation requires great cleanliness, so this was a major consideration.

¶ The plant is just on the edge of the city limits and would be involved in any future smoke ordinances.

¶ It was deemed advisable to consider our neighbors and see to it that we did not contaminate their grounds with soot and fly ash.

There are four main types of collectors: the bag type, the cyclone type, the electronic precipitator and the wet or water wash type.

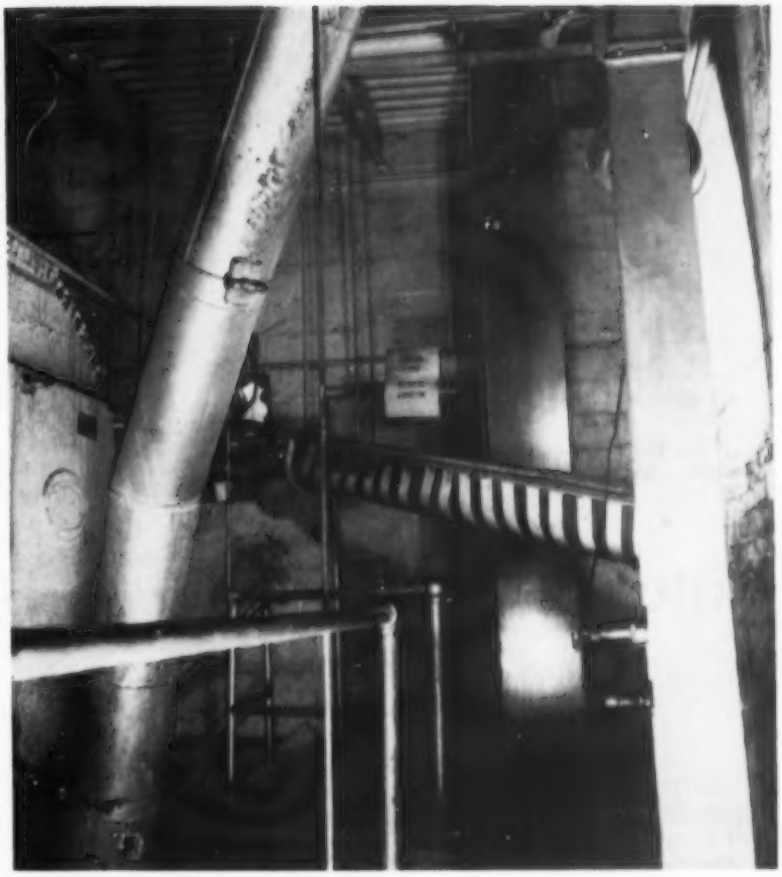
We believed adequate results could be obtained from the cyclone type and therefore obtained the advantage of lower purchase, maintenance, and operating costs. It has proved to be effective enough.

Coal Handling Equipment

We made use of our existing coal handling system and the new boiler was so positioned that it was merely necessary to run a screw conveyor from the main coal storage bin outside to the new stoker hopper.

We did, however, make the operation of the screw conveyor automatic in a unique manner. We tried to use hinged flaps to operate limit switches connected to the screw conveyor motor contactor, but this did not work at all satisfactorily. We then installed a conventional liquid level controller using two probes that are normally actuated by the conductivity of a liquid. In our installation the probes are actuated not by a liquid, as was anticipated by the manufacturer, but by the coal itself. We have found that it works very satisfactorily. The only trouble experienced was with very dry coals for which we had to increase the probe contact by installing some small plates on the end of the probes.

We have now been using the new boiler for almost two years and we are very pleased with the firing and control systems. The firemen are maintaining high efficiencies with very little supervision, and the winter presents no more steam generation problems for us.



Simple screw conveyor takes coal from the old storage bin to the new boiler.

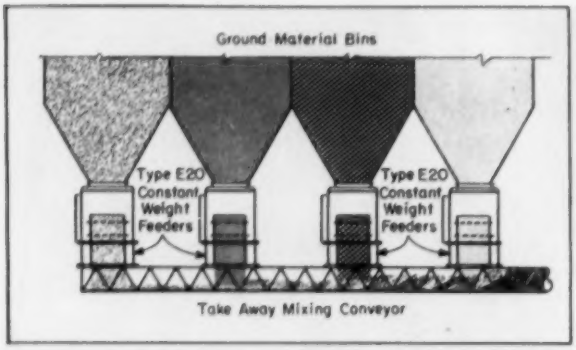


Fig. 1 — A continuous proportioning system needs little headroom, eliminates mixers, and has high capacity.

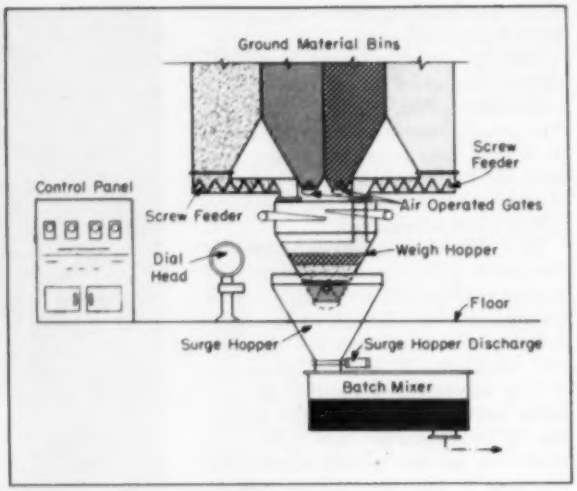


Fig. 2 — The batch accumulative proportioning system is highly flexible as to range of weights and settings.

Automatic Weighing of Bulk Materials

JOHN K. RUDD, Richardson Scale Company, Clifton, New Jersey

I&P EXCLUSIVE

INDUSTRY HAS now adopted automation and automatic equipment is reducing the number of people required to operate a plant.

The Elkhart County Farm Bureau Cooperative plant was among the first to make use of the fully automatic accumulative batch feed systems, and this plant arrangement is shown in Fig. 4. Here are shown the storage bins, feeders to the accumulative hopper scale, and the diverter spout which sends the discharges alternately to either of the two mixers.

Incoming bulk materials are stored in the near row of six bins and finished blended feeds are stored in the ten bins to the rear. The control panel for this system is shown in Fig. 7 and involves eight weight selectors, as no more than eight ingredients are used in any one formula in this plant. While not a part of the weighing system, the control panel contains the necessary pilot lights and controls for all of the conveying and mixing equipment in the entire plant. Thus, only one operator is required to take care of the blending and storage of the various feeds that the mill provides.

One aspect of automation is the automatic proportioning of ingredients by weight. In order for a plant to make use of automatic equipment for this purpose, certain basic requirements must be met. First, the system must be flexible. The controls must be designed so that the operator will be able to select individual ingredients, as all the ingredients might not be used in each formula. The weights of the selected ingredients must also be variable over the whole range required by all of the formulas to be compounded.

Second, the system must be accurate. It used to be that weight accuracy of 0.5 percent was good enough for the vast majority of applications, but with modern statistical quality control, the common tolerance is dropping to 0.25 percent and even 0.1 percent. The conventional dormant beam scale has been this accurate for a hundred years, but it will not fill the bill in an automatic process that requires remote indication, recording, totalizing, and remote formulation. It cannot be

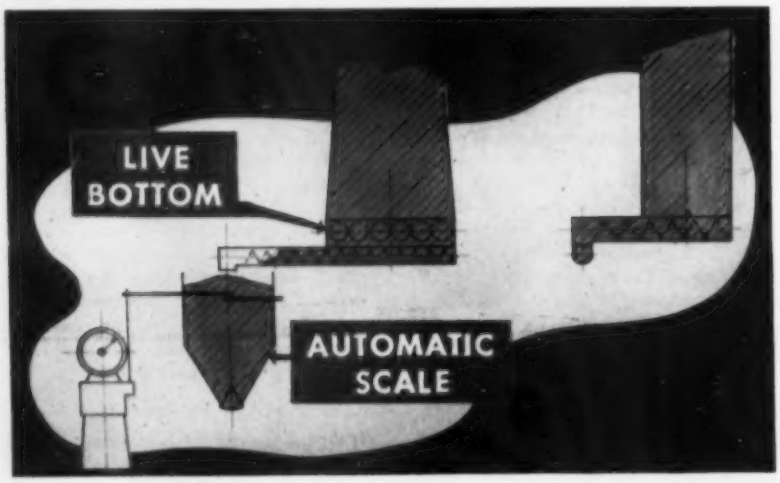


Fig. 3 — One of the most serious problems of automatic weighing is the inconsistency of materials. One solution is to use a hopper with a live bottom.

harnessed to a punch card system to do what the little holes tell it, and in turn, punch holes for material inventory control.

It must be as easy as possible for the operator to preset the desired correct weight of each material. It is also essential that the system continue to repeat these weights accurately as long as necessary. The system must indicate to the operator the reason for any major departure from its scheduled operation. There must be some provision for self-monitoring and alarms must be provided for abnormal conditions.

There are three methods in use today for proportioning materials automatically by weight. These are the continuous, the individual batch scale, and the accumulative batch scale methods.

Continuous Method

This involves the use of continuous weighers, one for each material. These machines are usually of the belt feeder type in which a portion of the belt bridges a weighing section which is connected to the beam system and thus indicates and controls the flow of material through the machine as a function of weight. The arrangement for a continuous system would be as shown in Fig. 1, where each machine discharges its material into a common conveyor that serves both to collect the ingredients and to mix them.

Individual Batch Scale Method

The individual batch scale method utilizes multiple discharges from individual scales. There is a scale for each ingredient, and these discharge to a common collecting and mixing conveyor in the same manner as with the continuous machine.

Accumulative Batch Scale Method

In the accumulative batch scale method all of the ingredients are fed accumulatively to a weigh hopper such as that shown in Fig. 6. This weigh hopper must be large enough to contain a complete batch, and hopper capacities of 125 to 300 cubic feet are not unusual. The arrangement of the accumulative system is as shown in Figure 2. The weigh hopper discharges its stratified materials to a mixer beneath the scale. Sometimes a diverter spout is provided beneath the scale so that the scale alternately feeds either one of two mixers.

Batch Vs. Continuous Weighing

While there will always be a place for the continuous weigher on cer-

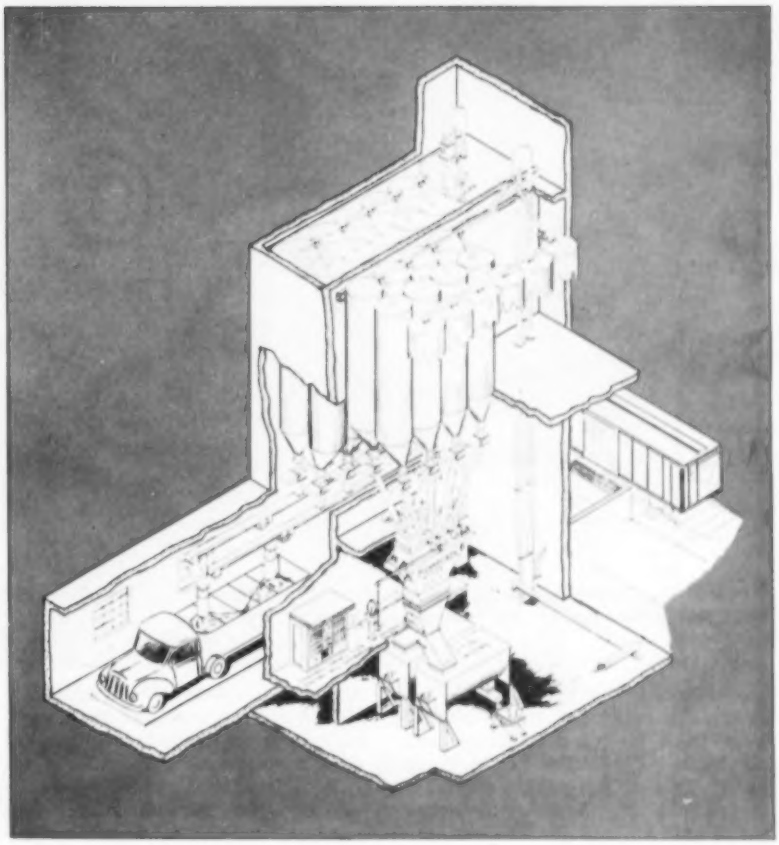


Fig. 4 — Raw materials are stored in the near row of six bins, automatically weighed, and blended. Finished feed is stored in the ten bins at the rear.

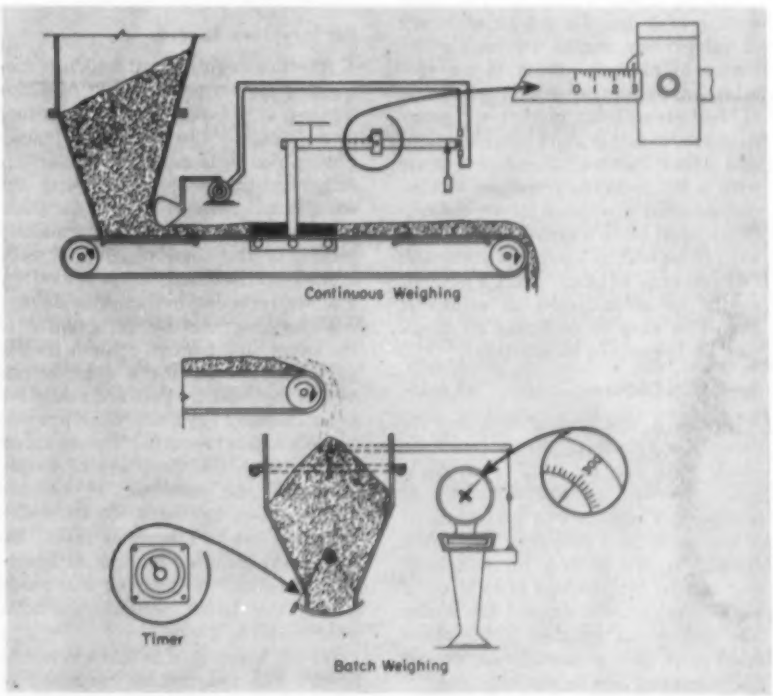


Fig. 5 — Continuous versus batch weighing. Batch method is more accurate.

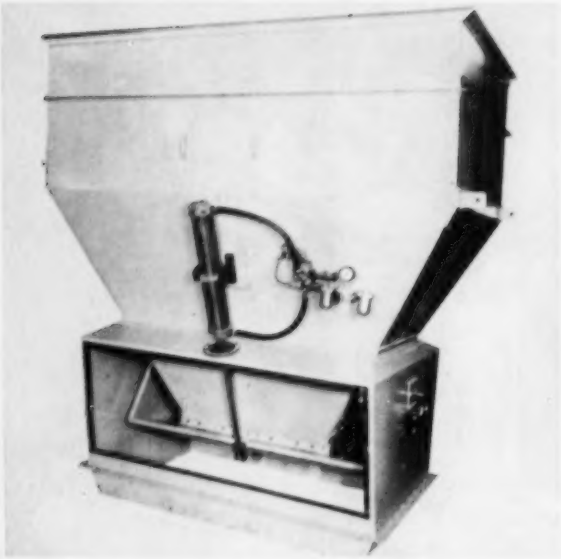


Fig. 6 — The weigh hopper used in accumulative systems must be large enough to contain a complete batch.

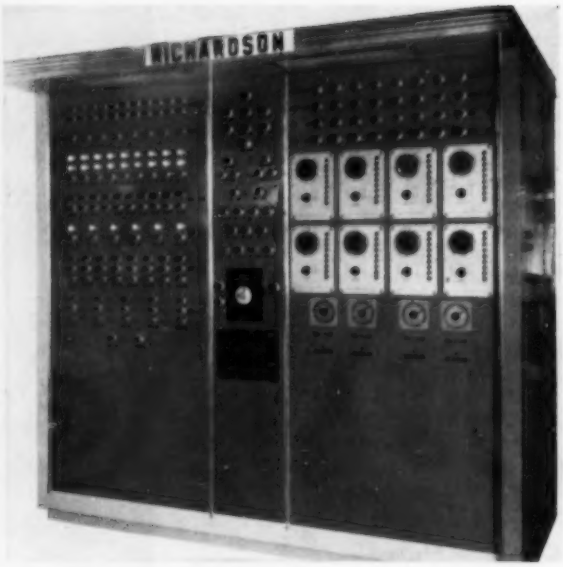


Fig. 7 — Elkhart installation control panel mounts eight weight selectors, all pilot lights, and controls.

tain materials, the batch scale is far more accurate and more readily lends itself to instrumentation and automatic control. The two methods of weighing illustrated diagrammatically in Fig. 5 show the scales set to deliver 300 lbs. per minute each. The continuous weigher, at a belt speed of say 100 feet per minute with one linear foot of belt on the weighing span, would have a scale setting of 3 lbs. To get an accuracy of one percent would require a sensitivity of plus or minus ½ oz.—almost impossible in practice because of belt tension, material shear strength, possible skirt plate friction, and other factors. The batch scale with a 300 lb loading and set to discharge once a minute by an electric timer need have a sensitivity of only 3 lbs to be within 1 percent accuracy. For this type of batch scale, 1 percent would be an unheard of error. It would be easy to maintain an accuracy of ¼ percent in practice.

Smoother Delivery

Where a continuous delivery to process is required, the one-minute batch feed can be ironed out by a lower feeder or the number of batches per minute can be increased from one to four or more. The batch system is self-testing for accuracy and can be interlocked to hold up if a weighing should exceed tolerance. The continuous weigher on the other hand does give a continuous stream and requires less headroom.

When twelve or more ingredients are involved, the completely automatic accumulative batch system is almost always cheapest even when the cost of the mixer is included. On smaller numbers of ingredients, the cost advantage may lie with the continuous or the individual batch systems, but the smaller number of ingredients required does not necessitate such an elaborate control system, and so the accumulative method may still be competitive in price.

For Inventory Records

Another requirement which is frequently encountered is that of maintaining a reliable inventory record of the usage of the various materials. Sometimes it is sufficient to have a tally on the scale to record the weight of material, and at other times the user desires a permanent record of the total weights of each ingredient handled, as provided by a chart recorder or printing device.

Depending on the complexity of the inventory control system in any particular plant, there are various means by which the accumulative proportioning system can provide the necessary records. The simplest is the batch counter, which simply indicates the number of batches weighed out by the scale since the last time the counter was reset. By noting the counter reading at specified times and multiplying this reading by the batch weight, the total production is given.

Where a count of batches is insufficient, the dial can be equipped to print the accumulative totals for each batch as the materials are successively weighed. A permanent record of each weighing is thus provided, but the individual ingredient weights must be found by substraction and the total usage of each ingredient determined by adding the appropriate individual weights. Another method, often used in conjunction with remote dial repeaters, is the circular chart recorder. Here a pen automatically traces the value of each weighing on a circular chart. A run of batches can be compared, and again by subtraction, the weights of the individual ingredients found. Each time that a new ingredient is added, the chart pen shifts, so that the trace for a complete batch looks like a series of small steps. The reading accuracy of the chart is seldom closer than about ½ percent, but the system has the advantage that successive batch records appear on a single chart.

Application

Automatic weighing seems inherently well suited to automatic or semi-automatic bulk handling installations. The weight sensing device can always be made to supply a signal to any one of a wide variety of instrumentation devices. Integration of automatic weighing with computer control devices, for instance, is already a reality. And as the new marvels of industrial control are unveiled, they can be applied to automatic weighing for still greater productivity and improved quality control in bulk materials handling by weight.

I&P EXCLUSIVE

Concentration of motor controls demonstrates the great importance of electric motors to industry.

Minnesota Mining and Manufacturing Co.

Modern Undervoltage Protection For Large A-C Motors

S. B. HOAG
Chief, Electrical Engineering Division
Chemical Construction Corporation

UNDERVOLTAGE occasionally occurs on the best of modern transmission lines or feeders as a result of lightning strokes, switching phenomena, application of sudden loads, phase-to-phase or phase-to-ground flashovers, or sluggish generator voltage regulation. Most electrical power and lighting equipment today is designed to operate satisfactorily within 10 percent of nominal design voltage without undue loss in efficiency or life expectancy. Beyond this 10 percent, however, apparatus is usually detrimentally affected in various ways unless precautions are taken. Among the seriously affected (and widely used) devices are large a-c motors — squirrel-cage induction motors, synchronous motors, and wound-rotor motors. Motors carrying the continuous load for which they were designed, therefore, should not be operated on a voltage less than 90 percent of normal. Certain undesirable changes begin to become significant at 90 percent of nameplate voltage (Table I).

Although motors operating at 10 percent, plus or minus, from normal voltage are not in real jeopardy, their breakdown and locked-rotor torques are reduced considerably. This, of course, is because torque varies as the square of the applied voltage. (At 90 percent of rated voltage, for example, the torque is $(.90)^2$ or 81 percent of full-voltage torque).

Table I suggests the more serious problems that present themselves when large motors are running and suddenly experience not a mere 10-percent dip, but suffer 30-, 50-, 60-, or even 100-percent dips. Since the locked-rotor and breakdown torques of an induction motor are seriously reduced at these greater voltage dips, it follows that the motor will "labor" under load. If not instantaneously unloaded (which is not always practicable in many important industrial processes) it will simply stall and will be seriously damaged if not disconnected within a specific time interval by its thermal or induction overload relays. (Synchronous motors are even more complexly influenced than squirrel-cage or wound-rotor motors. Their pull-in torque, pull-out torque, and many other inherent characteristics are quite sensitive to voltage dips.)

Why bother with undervoltage protection at all when overload relays, out-of-step relays, and such will eventually take the motor off the line? The answer is that it is far better to act immediately (or within a certain time interval) when low voltage exists, and to deenergize the motor, than to have it be disconnected the hard way. Current overload relays (and out-of-step relays

TABLE I

Motor Characteristic	Effect at 90 Percent of Rated Voltage	Effect at 110 Percent of Rated Voltage
Efficiency		
Full-Load	Decreases 2 to 3%	Increases 0.5 to 1%
Three-Quarter Load	Decreases 0 to 0.5%	Very little change
One-Half Load	Increases 1 to 1.5%	Decreases 1.5 to 2%
Speed		
Full-Load	Decreases 1.5 to 2%	Increases 1 to 1.5%
Free (No load, Synch)	No change	No change
Percent Slip	Increases 20 to 25%	Decreases 15 to 17%
Torque		
Locked-Rotor and Breakdown	Decrease 19%	Increase 21%
Power Factor		
Full-Load	Increases 1 to 1.5%	Decreases 2 to 3%
Three-Quarter Load	Increases 2.5 to 3%	Decreases 3.5 to 4%
One-Half Load	Increases 3.5 to 5%	Decreases 4.5 to 5.5%
Current		
Full-Load	Increases 11 to 12%	Decreases 7 to 8%
Locked-Rotor	Decreases 11 to 13%	Increases 11 to 13%
Temperature Rise	Increases 7 to 8 C	Decreases 4 to 5 C

in the protective control of synchronous motors) guard against mechanical overloads at normal voltage rather than against the ills of low voltage. Furthermore, a motor is taxed less in dropping out on undervoltage as such, before the consequences of undervoltage take place.

Protection Defined

There are three types of undervoltage protection. True undervoltage protection, or what has been called "three-wire control," is defined by the American Institute of Electrical Engineers in its *American Standard Definitions of Electrical Terms* as: "the effect of a device operative on the reduction or failure of voltage to cause and maintain the interruption of power in the main circuit." In other words, if the voltage to a running motor should suffer a serious reduction in voltage (say to 85 percent of normal or less) or a total loss of voltage, it will be disconnected without undue delay from the supply circuit having the undervoltage. It shall remain disconnected even though the supply voltage may be restored to a satisfactory value. Only deliberate reconnection by a manually operated control device will permit reenergizing of the equipment. The important point is that restoration of supply voltage in itself will not reenergize the equipment. Intentional, manual reconnection is required after the correct nominal voltage is restored.

The AIEE defines time undervoltage protection, which is really undervoltage protection with a time delay feature added, as: "the effect of a device operative on the reduction or failure of voltage to cause and maintain the interruption of power in the main circuit if the voltage reduction continues for more than a predetermined time interval." This type of protection is time selective. Should the voltage seriously diminish, the equipment will continue to be energized from, or can be reconnected to, the source during a known, limited time. Where the motor and its coupled machine have a large combined moment of inertia, and where there is perhaps some fraction of the motor full-load torque available to aid rotation, the combination of motor and machine may be capable of coasting through a voltage dip lasting as long as three or four seconds. In such cases, delay timing in the undervoltage protection is not only feasible, but it is advisable. The higher the machine speed maintained during the voltage dip, the lower the inrush current upon return of voltage.

Lowvoltage Release

Again by AIEE definition, lowvoltage release undervoltage protection (commonly known as "two-wire control") is: "the effect of a device operative on the reduction or failure of voltage to cause the interruption of power in the main circuit, but not to prevent the reestablishment of the main circuit on return of voltage."

Although lowvoltage release does not offer the safety of true or time undervoltage protection, it is frequently employed with various pilot devices for simplicity or for economy. But the user should be fully aware of the technical limitations

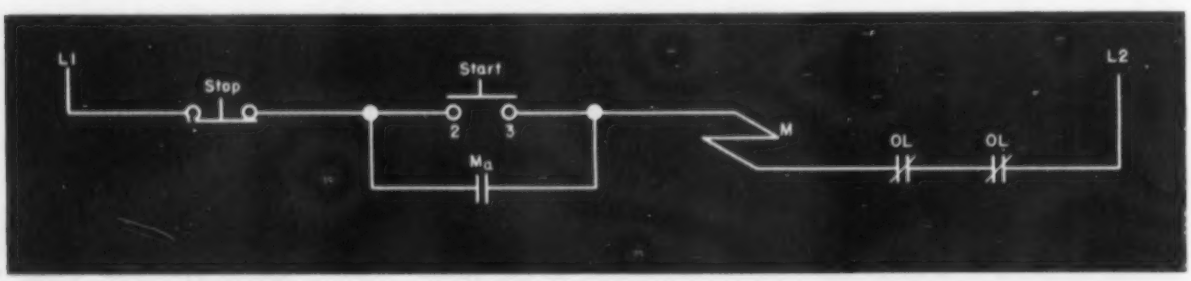


Fig. 1 — The basic control circuit embodying undervoltage protection uses an auxiliary starter contact to keep the circuit closed after the "start" pushbutton is released. "Start" button must be pushed to start motor after voltage dip.

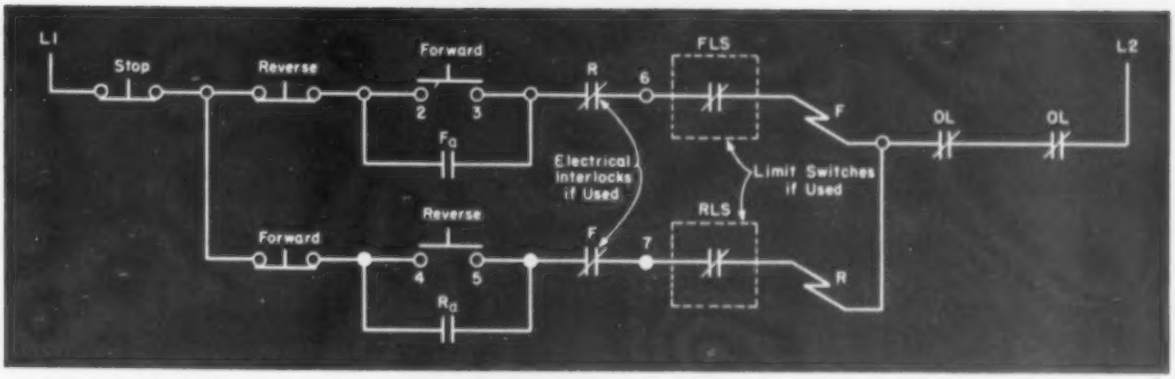


Fig. 2 — An extension of the arrangement shown in Fig. 1 is this circuit for controlling forward and reverse motor rotation. The reversing feature is accomplished by having duplicate starter elements, one for each rotation direction.

and safety shortcomings of "two-wire control."

Since motor starters using low-voltage release will drop out and pick up at arbitrary voltage values somewhere below the acceptable 90-percent point, the affected motors will automatically stop and start in response to the voltage fluctuations. This automatic restarting on return of voltage without exercise of an operator's judgment has many undesirable features. Unless installed with care, "two-wire control" or lowvoltage release may jeopardize the safety of persons who must repair, maintain, or examine motor-driven machines using such a control. The ever-present hazard is that apparatus at rest (such as screw conveyors, crushers, elevators, grinders, mixers, classifiers, and agitators) may suddenly restart upon the return of voltage if no control lockouts are provided.

"Two-wire control" should be used only where necessary — that is, where motor-driven equipment must be pilot controlled, is unattended, is in a remote or inaccessible location, and where it must be placed in service quickly upon voltage restoration.

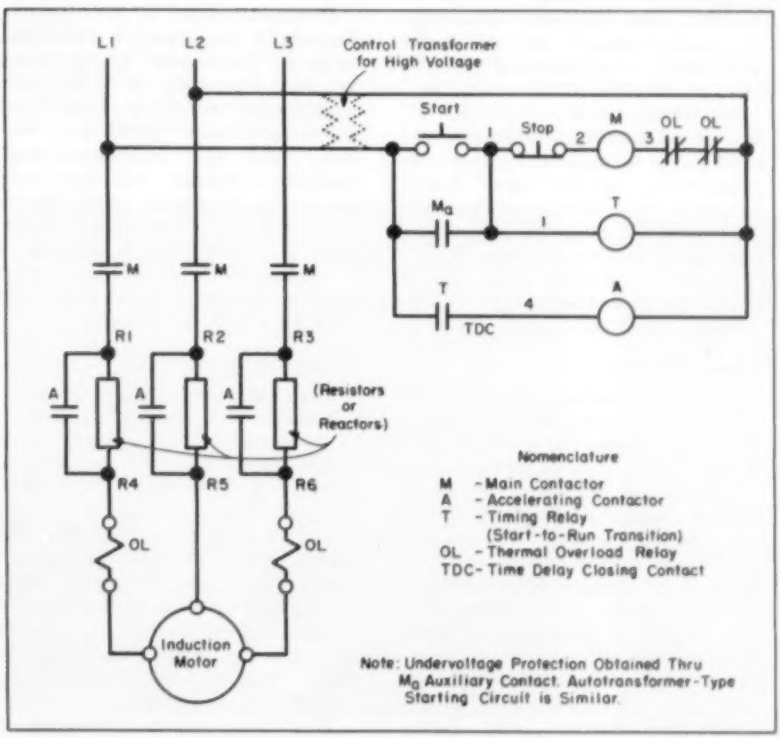


Fig. 3 — The arrangement of Fig. 1 can be adapted to magnetically operated reduced-voltage control using autotransformers, resistors, or reactors.

Reduce Danger

No rotating machine, of course, is harmless. But there are some instances where the danger is somewhat reduced by enclosures. For example, an enclosed fan, blower, or pump with a totally enclosed motor would present less immediate danger due to rotating parts than more open motors and unproteeted equipment such as open agitators or open screw and belt conveyors. If "two-wire control" is used, a disconnecting means should be provided with lockout at the control center or at the motor in the control circuit.

The lockout key should be in the sole possession of the person working on those machines having a motor with lowvoltage release. A conspicuous danger sign should be located at such motors, clearly warning that the motor is on lowvoltage release. All control circuits should be locked open prior to inspecting, maintaining, or repairing such equipment while it is at rest.

When a plant has large motors or a number of small or medium motors on "two-wire-control," a serious drop in voltage will stop the entire group. Upon restoration of system voltage, the summation of the total inrush current may drag the system voltage down greatly. The voltage to the group may thus remain low due to the mass restarting. Assuming the motors must all be kept on "two-wire control" because of pilot devices, sequential automatic restarting may be necessary. As the phrase implies, the motors will be started up in groups of one, two, or

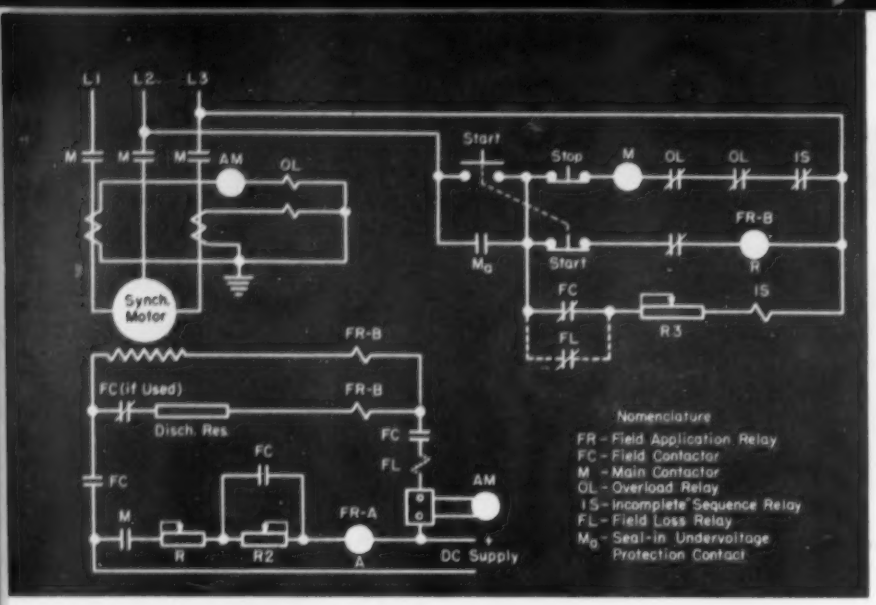


Fig. 4 —Synchronous motor control looks complicated only because of d-c field system. Basic method of undervoltage protection is the same as shown in Fig. 1.

three through proper timing devices and relaying. Thus the total inrush current at any instant is restricted and the system voltage can recover.

Circuit Voltages

The majority of large motors (arbitrarily, 200 hp and above) operate on the higher voltages such as 2200, 4150, 6900, and 13,200 volts. However, there are many instances where motors as large as 700 or 800 hp may be energized from 440 or 550 volts. Whether a motor is "large" or "vital" is therefore merely a relative term with reference to the other motors in a plant. Any discussion of large, a-c motor undervoltage protection should, therefore, include 440- or 550-volt control as well as control for motors at the higher voltages.

Undervoltage protection as such (as mentioned previously) does not incorporate any time delay in disconnecting a motor from its feeder upon complete loss of voltage or upon a serious voltage dip. This disconnection is considered instantaneous to all intents and purposes. The simplest, and most direct, method of true undervoltage protection for large, lowvoltage motors is one that employs a "seal-in" contact (auxiliary starter contact) connected in parallel with the "start" pushbutton (Fig. 1). This is commonly known as "three-wire" control, since this usually is the number of control wires that run from the "start-stop" pushbutton station to the starter.

Referring to Fig. 1, undervoltage protection is obtained as follows: The operator pushes the "start" button, energizing coil "M" of the main contactor. This closes the main contactor, closing contacts "M." Also closed are auxiliary contacts "M_a", which are mechanically attached to the mechanism of the main contactor "M". When the operator takes his finger off of the "start" button, auxiliary contacts "M_a" keep the main contactor coil "M" energized.

Upon loss of voltage between L1 and L2, which also is the motor supply, main contactor coil "M" is deenergized, simultaneously opening the auxiliary "seal-in" contacts "M_a." Upon restoration of voltage, coil "M" cannot automatically reenergize and start the motor until an operator deliberately pushes the "start" button as before. This system is used on forward and reversing (Fig. 2) motor control as well as for magnetically operated reduced-voltage control employing autotransformers, reactors, or resistors (Fig. 3).

Manual Restart

Manually operated reduced-voltage starters usually have a holding latch that retains the starter handle in the running position as long as the supply voltage is high enough to secure the latch. A drop or loss of voltage will weaken the latch coil and permit the starter handle to return to the "off" position. Manual restart by the operator is necessary after the voltage is restored. Although there are exceptions, manually operated, reduced-voltage starters are not popular on very large motors because the accurate relay timing necessary for smooth transition from starting to running is not available in manual starters as it is in the magnetic reduced-voltage starters.

Fig. 4 illustrates low-voltage synchronous motor control employing a magnetic starter. Although the diagram is more complex in appearance because of the d-c field control, the same basic method of undervoltage protection is obtained through the "M_a" auxiliary contact as is with the various induction motor controllers.

Use Circuit Breakers

In many installations, it has been found practical as well as economical to employ circuit breakers as motor starters for large squirrel-cage, wound-rotor, or synchronous motors. If the breaker is latched closed, a 12- or 24-volt tripping battery is usually employed in conjunction with an auxiliary voltage relay. Upon losing voltage, the relay coil will deenergize, dropping the relay armature, closing contacts to energize the trip coil of the breaker, unlatching it, and thus stopping the motor. Capacitors are often used for undervoltage tripping, their stored d-c energy being used instead of a battery to trip the breaker. Various means of time delay can be introduced in the relay circuit such as capacitors, induction discs, air- or oil-actuated pistons with cylinders, pendulum or spring escapements, or bimetallic thermal elements.

Pneumatic delay is quite popular because of its accuracy and low time settings. Pneumatic timing relays are used frequently in combination with special "momentary-start" and "maintained-stop" pushbutton stations (Fig. 5). "Maintained-stop" pushbutton stations are used with pneumatic or similar timing relays to provide a time lowvoltage release. Automatic restarting is assured if the voltage returns to 85 percent or more of its normal value within the time for which the relay is set.

Timing Easily Adjusted

Pneumatic timing relays are easily adjusted over a range of 0.2 seconds to 3 minutes. The normally open "start" button of the pushbutton station is a momentary contact while the normally closed "stop" is a maintained contact. After depressing the "stop" button, the normally closed contacts will remain open — eliminating the necessity of holding the button depressed until the timing relay has timed out. Depressing the "start" button automatically closes the maintained contact.

Time undervoltage protection is more complex than the instantaneous type, but it is becoming more and more prevalent in large motor con-

trol. A typical capacitor-type, time delay undervoltage release consists of a two-pole, normally open control relay, an electrolytic capacitor, and a rectifier. For operation on 440 or 220 volts, a step-down transformer is included. For operation on 110 volts, this transformer is not needed. All devices are equipped with a resistor that introduces about two seconds of time delay. To obtain approximately four seconds of time delay, this resistor should be removed.

Used with a separate magnetic starter and momentary contact pushbutton, operation is as follows (See Fig. 6): Pressing the "start" button immediately closes the control relay "CR." In turn, a contact of this relay energizes the operating coil "M" of the magnetic starter. The relay coil "CR" is kept energized through its other normally open contact after the "start" button is released. The electrolytic capacitor is charged through the rectifier.

Capacitor Discharges

Upon failure or reduction of line voltage, the capacitor discharges through the control relay coil "CR" and keeps it energized. The time required for the capacitor to discharge is dependent upon the time constant of the circuit. This is a function of the resistance in the circuit and the rating of the capacitor. If the line voltage returns to 85 percent of normal before the capacitor has been sufficiently discharged to drop out "CR," the magnetic starter coil "M" will automatically close the main contactor and restart the motor. If the voltage does not return to normal before the capacitor has discharged, the control relay will open its contacts "CR." It then becomes necessary to operate the "start" pushbutton when power is restored to get the motor operating again.

Pushing the "stop" button at any time drops out the control relay "CR," immediately opening the starter circuit.

Keep Motor On Line

In all time undervoltage control, the aim is to keep the motor on the line for one to three seconds following voltage failure. However, the system must be selective so that the operator can trip off the motor instantaneously through a pushbutton or similar manual control. Care must be exercised in using some types of capacitor time delay relays in conjunction with remote pushbutton stations. Long control runs introduce capacitance coupling problems between the wires. This may cause timing errors, or may not permit the motor controller to drop out at all in some instances.

There are four points to consider in the application of undervoltage time delay protection for an existing or proposed plant where large or vital machines are being electrically driven:

¶ Investigate the vulnerability of the incoming utility lines to lightning disturbances, unusual switching, or special loads. If power is locally generated in the plant, anticipate voltage dips from the application of large loads to system generators. Such knowledge and analysis is the proper starting point in time undervoltage protection control.

¶ Next, list and analyze all motors in the plant — checking the importance of their loads with special attention to large synchronous motors. (If retained on the system, synchronous motors will help keep the voltage up during dips.)

¶ Check automatic unloading possibilities along with moments of inertia of all machines having true undervoltage or time undervoltage protection. The higher the motor speed that is maintained during a voltage dip, the less the shock to the system due to inrush currents upon return of voltage. In the case of synchronous motors, time delay will improve the possibilities of resynchronizing quickly, and avoiding dropping the motors due to the action of out-of-step or due to the action of overload relays.

Check Reliability

¶ After proper undervoltage control has been selected and installed, test it with simulated voltage losses and dips prior to putting the plant into actual service. Set up a program of maintenance and checking, paying special attention to time calibration and to the condition of timer components (such as bellows in pneumatic types, capacitors, and so forth). Protection is only as reliable as the components it depends on.

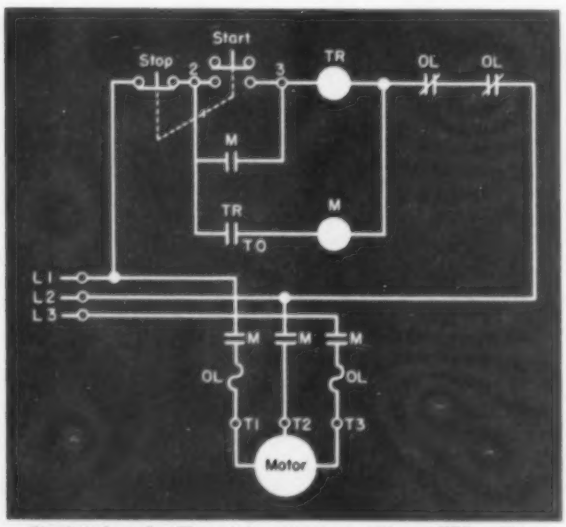


Fig. 5 (above)—Time delay element, such as "TR", will let motor coast through minor voltage dips for short time.

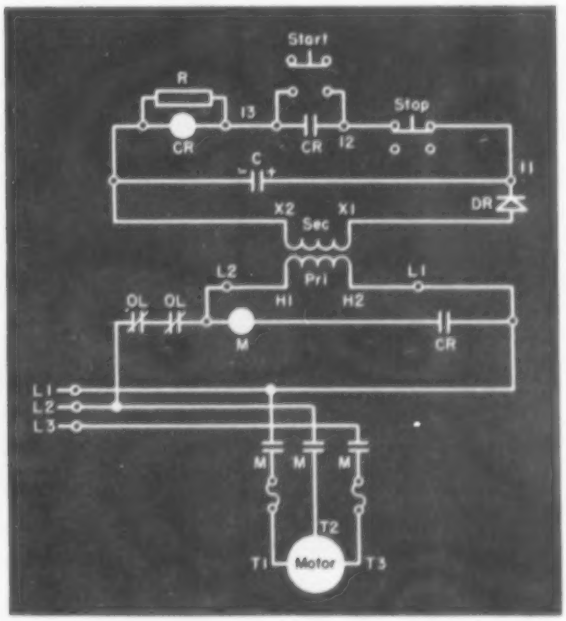


Fig. 6 (right)—Energy stored in capacitor "C" keeps control relay "CR" energized, providing some time delay.

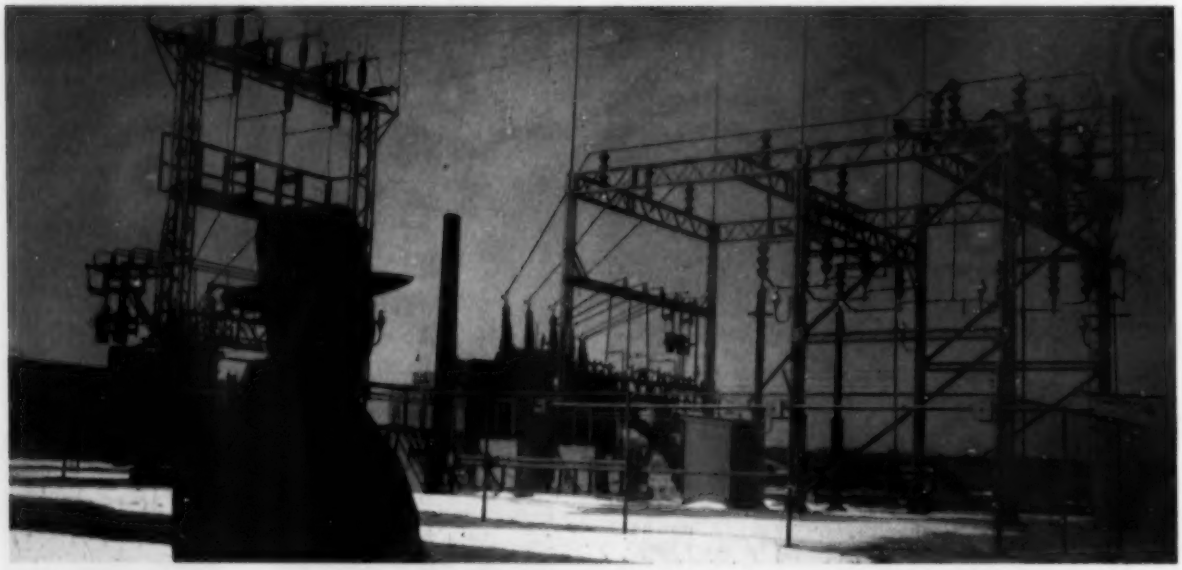
"This is our plant. Makes chlorine, hydrogen, and caustic soda from salt. Powerhouse is at upper left, behind the pond."

I&P EXCLUSIVE

Pioneer In Michigan's Lake Country

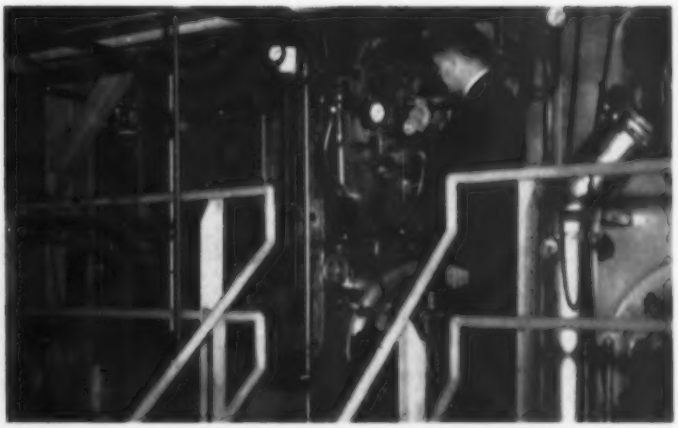
JOSEPH TARDIFF is running the first chemical plant of many that will be turning the old lumbering country just north of Muskegon, Mich., into a modern industrial community. Though the neighboring plants are still in the planning stages, Tardiff's has just rounded out its first year of proving that industry can be com-

"Link-Belt traveling screen cleans water coming from cribs on bottom of lake 250 ft from pumphouse."



"Power comes in here. Allis-Chalmers transformer (left) is 5000 kva at 44 kv. Pennsylvania unit is 15,000 kva at 140 kv."

"Talking over 500-cfm Worthington compressor with George Duckwall, plant engineer."



"This is the burner deck of our No. 2 boiler. It's a Riley Steam Generator rated 10,000 lb per hr at 150 psi. We have two such units."

patible with the more tranquil surroundings of such a site. There is no noise and no air pollution from his plant. He returns water to the nearby resort lake cleaner than it is when he takes it. And he takes 6½ million gallons a day.

Tardiff started with Hooker Electrochemical Company at Niagara Falls, N. Y., during his junior year in college. (Graduated Dartmouth in 1937.) First, he was a control chemist. From that, he went on to become a technical foreman, a safety engineer, and then an area supervisor in the Niagara Falls plant.

In January, 1953, he was appointed works manager of the new chlorine-caustic soda plant then being built in Montague, Mich. It was co-designed by Hooker's Niagara Falls engineering staff and the builders — H. K. Ferguson Company. Tardiff was thus in the happy position of being available while the plant was still being designed.

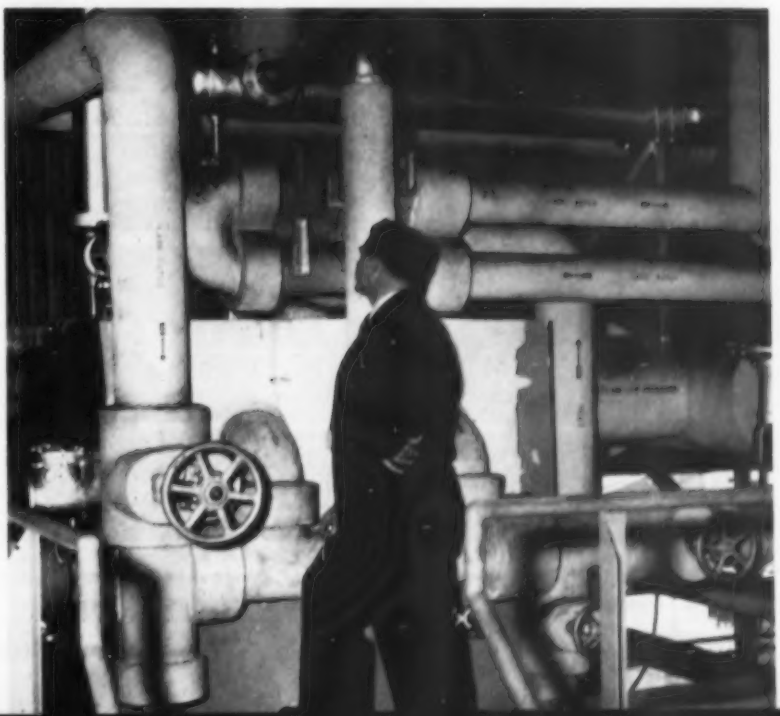
He worked with many Hooker people who had a significant part in the plant's design — Hiram B. Young, vice president in charge of Eastern production; Donald E. Springer, chief engineer; Deane O. Hubbard, project engineer for the Montague plant; and George Duckwall, plant engineer.

The plant property amounts to 700 acres and covers some 700 million tons of salt—one of the plant's basic raw materials. The eight major buildings enclose 124,000 square feet of floor space. There are some 28 miles of piping in the plant.

Before long, Tardiff will have some neighbors. Du Pont and Union Carbide soon will have plants adjoining Hooker's pioneer in the Michigan lake country.

"Here's control panel of one of four I-T-E mechanical rectifiers supplying chlorine-caustic soda cells. Each unit is rated 10,000 amperes at 400 volts."

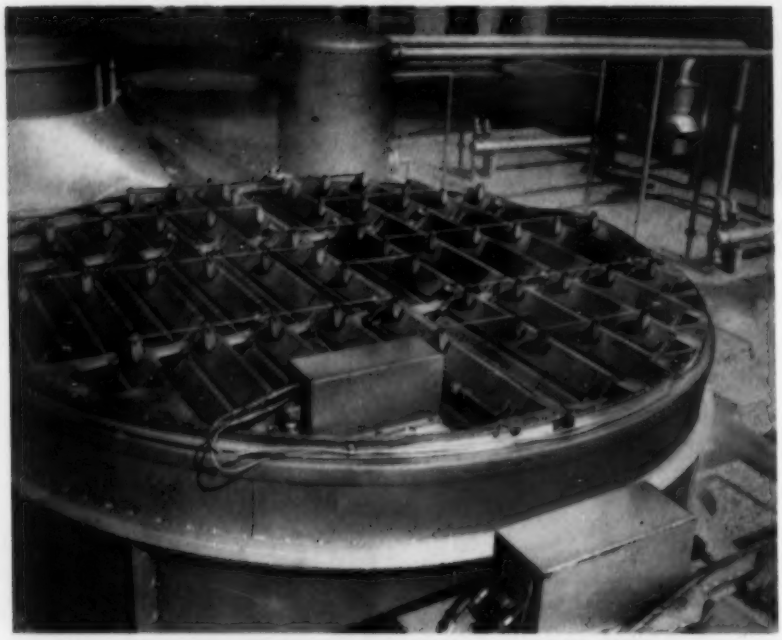
"Checking the temperature of the lake water coming from the pumphouse into our Cochrane deaerator. This one was brought from our Niagara Falls plant."



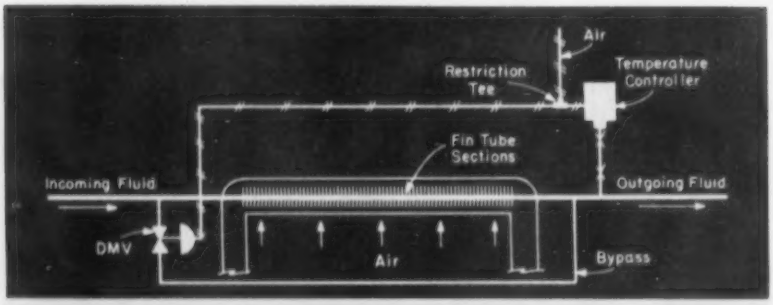
Temperature Control of Air-Cooled Heat Exchangers

I&P EXCLUSIVE

R. G. CAMERON
Industry Engineer
Minneapolis-Honeywell Regulator Co.
Industrial Division



Pneumatic power automatically positions the multi-blade damper on this gas cooling tower in response to remote bulb temperature controller.



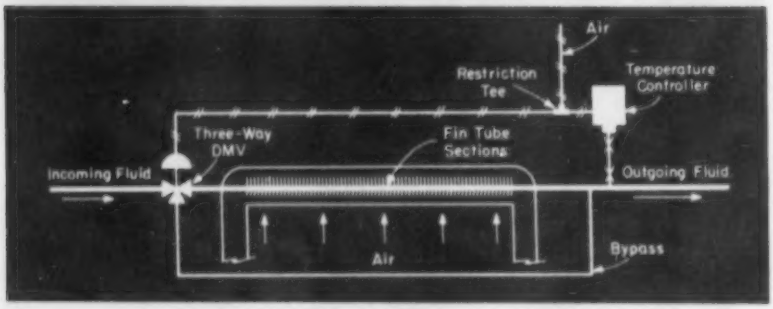


Fig. 1 (above) — Basic system bypasses fluid in response to temperature.
Fig. 2 (below) — Use of three-way valve permits bypassing all the fluid.

ADDING AUTOMATIC temperature controls to air-cooled heat exchangers and cooling towers is an inexpensive method of increasing their efficiency, protecting them against freezing in extremely cold weather, and assuring that they operate at the most economical level under diverse and widely varying climatic environments.

A properly designed and applied temperature control system adapts the exchanger to any ambient condition so that it always operates at maximum efficiency and so that the fluid temperature is more or less stabilized. An automatic control system prevents the formation of hydrates and resulting freeze-ups in winter. It permits immediate and continuous operation at full cooling capacity, both in summer and between seasons when the ambient air temperature varies widely between day and night.

Automatic fluid temperature control can be achieved in many ways. The system may be as simple or as complex as conditions may demand. The wide variety of instruments, nonindicating controllers, valves, relays, motors, power units, and dampers that are available today makes it a relatively simple matter to custom engineer the system to fit the particular needs in any application. The control systems shown here are essentially pneumatic. Electric, pneumatic, or combinations of these two kinds of systems can be used, however.

One of the simplest systems, but one that will give good results under many conditions, is quite inexpensive. It can be installed with little modification of existing equipment (Fig. 1). It consists of a diaphragm motor valve (either globe or butterfly) and a pneumatic remote bulb nonindicating proportional temperature controller. An indicating or recording thermometer controller, when desired, can be substituted for the nonindicating controller.

The outgoing fluid temperature is sensed by the temperature control-

ler bulb. The valve in the bypass line opens and closes to bypass just enough fluid to keep the outgoing fluid temperature from falling too low. This system works best where extremely low ambient air temperatures are not frequently encountered, but where an efficient heat exchanger would lower the fluid temperature to a critical value if no fluid were bypassed.

Bypass Entire Flow

Substitution of a three-way or butterfly diaphragm motor valve at the junction of the inlet and bypass line (Fig. 2) utilizes the same type of temperature controller, but yields more positive control. Since it is now possible to bypass the *entire* flow around the heat exchanger, this system is suitable for lower ambient air temperatures than the one shown in Fig. 1. The bypass must be protected, however, to prevent freeze-ups in the event of extremely low outside air temperatures.

The system shown in Fig. 3 combines the bypass technique with automatic control of a propeller fan. It consists of a diaphragm motor valve (either globe or butterfly), a remote bulb nonindicating pneumatic temperature controller, and a pneumatic-electric relay.

The fluid again is bypassed as shown in Fig. 1. In addition, the pneumatic-electric relay will be actuated when the controlled air from the temperature controller reaches a predetermined pressure. The temperature controller, therefore, indirectly controls the fan motor so that the fan operates only when a high percentage of fluid is flowing through the fin tube sections. The relay can be used, also, to control the fan in *on-off, high-low,* or *off-low-high* sequences.

Control Air Flow

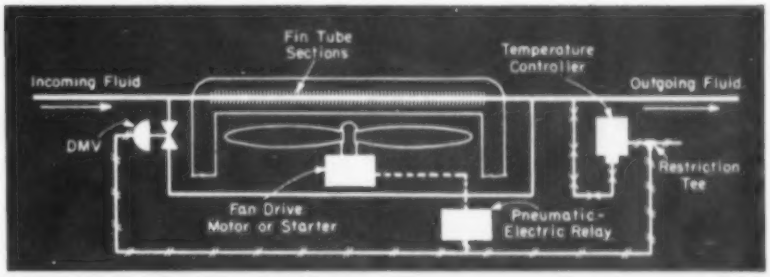
Another approach to temperature control of air-cooled heat exchangers is to control the air flow through the finned section rather than to divert the fluid being cooled. Control of the air flow is accomplished through the use of dampers operating in unison at the command of a temperature controller (Fig. 4). Where the air temperature swings are not too wide, a single damper installed atop the tower frequently provides adequate control.

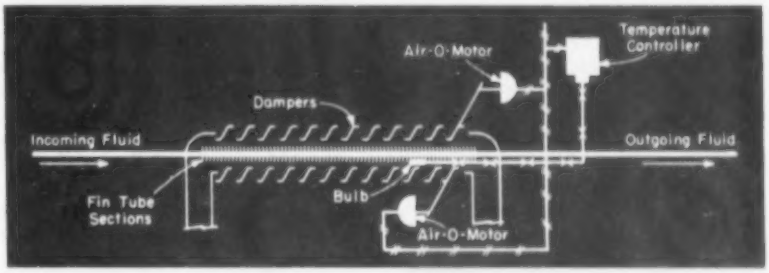
A two-damper system is excellent for extremely cold conditions because it prevents passage of any air over the tube sections when the air falls to a predetermined temperature. This virtually eliminates danger of freezing the fluid. The possibility of extremely cold ambient air requires use of both inlet and outlet dampers. Such a two-damper system, for example, is used on one gas cooling tower that is designed to operate in ambient air temperatures as cold as -40 F. Automatic control is actually mandatory under such circumstances.

The cooling tower controls the fluid temperature through the use of nonindicating controllers, dampers, and diaphragm-motor-driven dampers. The tower is totally enclosed, with a discharge air damper and an inlet air damper operating in unison. A temperature controller senses the temperature of the air stream as it enters the cooling fins of the tower, and positions the damper to prevent ambient air cooler than 60 F from entering. (This cooling tower is working on gas that forms hydrates that freeze at approximately 50 F.) The automatic control system has prevented any shutdowns that might have occurred because of freezing. Yet, it has allowed operation of this same cooling tower at maximum capacity in ambient air temperatures of 100 F during the hot summer months.

Fig. 5 shows a system that consists of a damper, damper motor, pneumatic-electric relay, and nonindicating remote bulb pneumatic temperature controller. Here, the temperature controller causes the damper motor to open and close the damper in a proportioning action as the outgoing fluid temperature rises and falls. When the damper has opened sufficiently, the relay causes the fan to start. It then stops the fan when the air temperature drops and the damper closes to a preselected position. The fan operates only when it is needed for the most efficient cooling. The finned section is protected, also, against the dangers of low temperatures.

These are only a few ways of doing the job. Modification and adaptation of these basic systems can be accomplished to meet the need of most any application.





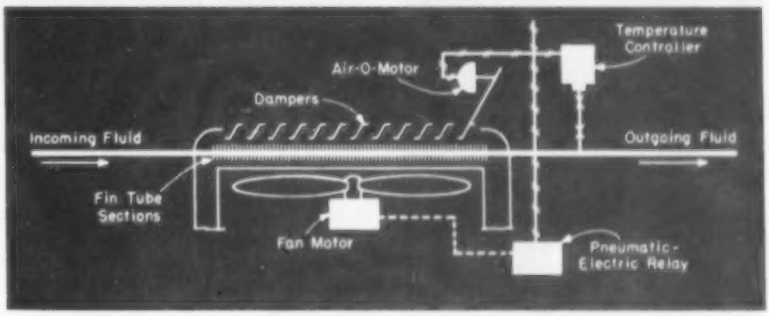


Fig. 3 (top) — Bypass control of fluid can be combined with fan control.
Fig. 4 (middle) — Temperature controller can position the air dampers.
Fig. 5 (below) — Damper control and fan control easily can be combined.

Briefing the sessions . . . .

American Power Conference

INDUSTRIAL POWER consumption will contribute significantly to the doubling of the electric power industry's present peak load—expected to occur by 1965. This was told to the opening session of 17th annual American Power Conference, held on March 30-April 1 in Chicago. John W. Evers, president, Commonwealth Edison Company,

John W. Evers, president, Commonwealth Edison, addresses Conference.

cited some estimates of industrial consumption that contribute to this prediction. "They (power industry leaders) say that consumption of electrical energy by the steel, aluminum, and paper industries will expand by 100 percent. . . . They say that use of electricity by chemical, rubber, and textile industries will expand by 50 to 60 percent. They say industrial lighting will be using 60 percent more electricity. They say air conditioning will be using 230 percent more. . . .

"They also tell you that entire factories will be operated by push-button machines. The word they use is 'Automation. . . .' We are reasonably certain that, some day, nuclear power will compete economically with our conventional plants. We look forward to economic nuclear power as a favorable prospect for both Commonwealth Edison and the electric industry at large. It is not unlikely that this prospect may become reality by 1965."

Start Industrial Boilers Fast

Fast starting procedures for 150,000-pound-per-hour, pulverized-coal-fired boilers were reported in which boilers were put on the line within 90 minutes of firing, starting from room temperature. C. E. Morrow, factory planning engineer and R. F. Born, mechanical engineer, reported on their work in the Hawthorne Works power plant of the Western Electric Company. "It was possible to place boilers on the line after 60 minutes of firing, if the units have been off the line as long as 50 hours. . . . In general, the problems (involved in fast starting) seemed to be largely associated with assuring adequate circulation in the boiler and holding superheater metal temperatures down to those necessary during the period while trapped condensate was either being blown from or evaporated from pendant loops. In accordance with these principles, instrumentation was provided to measure temperatures at approximately 60 points and means provided to determine distortion of boiler structure.

"A system of firing was developed so that large amounts of fuel input could be made, but temperature of the gas is reduced before reaching the high temperature superheater. This was accomplished by opening the upper burner air registers and firing only the lower two burners." Consultation was held with the engineers of the Riley Stoker Corporation in planning the development of these fast starting procedures. "Three . . . boilers manufactured by Riley . . . have been in operation at (Hawthorne Works) for more than two years supplying through a header system all steam requirements for process, electric power, compressed air and building heat.

"The steam plant operates on a load factor of about 60 percent so that daily and weekend boiler starting must be done. These boilers have generally been started according to boiler manufacturer's recommendations. . . . This represents an interval of about 4½ hours, and considerable attendance is necessary when following a starting procedure of such duration. An outage of process equipment for that period is costly when an emergency condition arises requiring that an idle boiler be placed in service. On this basis, it was considered most desirable to reduce the manufacturer's recommended starting interval by whatever amount that could be determined through a series of starting tests."

This paper concluded "Fast starting procedures result in lower stressing of the boiler structure as a whole as evidenced by reduced measurements of distortion during the expansion period. These results are obtained because the relatively high gas velocity through the boiler passes provides more uniform distribution of gas flow across the unit. Temperature differentials between drum metal temperatures and water contained therein are reduced in a fast procedure because circulation is more rapid and uniform across the width of the drum. It is the author's opinion that the fast starting procedures developed during this investigation are entirely practical and of considerable advantage with respect to strain that the boiler must be subjected to, time of attendance required and increased flexibility and dependability of boiler plant operation."

New Packaged Air Preheater

In a paper by E. Hammond and C. L. Brown, the Air Preheater Corporation, it was announced that the advantage of the "packaged" concept can be applied to small standard air heaters with similar advantages as are obtained in other "packaged" equipment — such as boilers. The authors pointed out that small air heaters cost more per million Btu's per hour than do large ones. This, they point out, has "in the past made it difficult to justify boiler heat recovery equipment in the small plant. However, present circumstances indicate that this situation should be carefully reviewed.

"First of all, the cost of fuel is becoming a large item of operating expense. . . . The price of fuel, if considered upon a broad base of time, has followed a rising trend." The authors thus pointed out that

heat recovery becomes more economical because the unit costs of fuel saved have been increasing over a period of time. They went on to describe a package heater fabricated in eight sizes "which allow it to be used with boilers covering a range from 25,000 to 150,000 pounds per hour of evaporation. . . . These packaged air heaters are shipped completely assembled with heating element in place and seals set. Erection consists simply of setting the heater on its foundation and making electrical and steam, water or air connections where needed. . . .

"In addition to the development of a packaged (unit) for use with boilers, the need for heat recovering equipment is also important in process industries. To illustrate the use of a packaged (unit) in this industry, two cases are cited. In the first case, a packaged (unit) was proposed in a paper drying process for the conservation of steam which in turn reflects as fuel savings. . . . In the second case, a drying process is involved also, but for drying automobile bodies. . . .

"The ever rising cost of fuel warrants the investigation and evaluation of heat recovery equipment by the operators of industrial steam and process plants. The development of the packaged regenerative air preheater makes the pay-off period of this type of equipment attractive to these operators."

Another Fuel — The Atom

"Atomic energy is simply another fuel for the production of electric energy." So spoke James F. Fairman, vice president, Consolidated Edison Company of New York. He pointed out that energy is bought as raw material in the shape of coal, oil, or natural gas. After a little processing the finished product is derived as electricity.

"In simplest terms" he said, "our immediate problem is how economically to use atomic energy as a replacement of or supplement to conventional fuels. . . . We are willing to mix our fuels as we have long since learned to do to advantage. . . . We hope ultimately to obtain and to pay for our atomic fuel in much the same manner that we do for our other types of fuel."

Dry or Liquid Transformers?

Depending on the type of application, one of four basic types of transformers can be selected for any industrial installation: oil filled, askarel filled, ventilated dry, or sealed dry. In a paper by W. M. Terry, Jr., Allis-Chalmers Manufacturing Company, the basic considerations that operate in the selection of transformers were comprehensively reviewed.

Terry commented "Let's consider the modern ventilated dry type transformer. This unit has been increasing in popularity due primarily to favorable operating experience in the field. The ventilated dry type transformer is available in insulation classes, 15 kv and below. Sizes range from the smallest distribution transformer up to large forced air cooled units with a maximum rating of 12,000 kva. The Atomic Energy Commission has standardized on and has used millions of kva of dry type ventilated transformers in their materials processing plants. These units ranging in size up to 10,000 kva forced air or 7500 kva self cooled.

"One disadvantage of the ventilated dry type transformer, as well as the sealed dry type transformer, is the ten decibel higher standard noise level of this type of unit as compared to oil and askarel liquid filled transformers. The higher noise level is due primarily to the fact that there is no attenuation of core generated noise such as occurs in liquid filled units due to the insulating fluids surrounding and impregnating the unit. Since many dry type transformers are installed in buildings, air borne noise may not be as much of a factor as vibration transmitted from the core and coil element through the case to the surrounding structure. To eliminate this vibration isolators may be applied between the core and coil element and the base of the case to eliminate vibration transmission. Cases have occurred where vibration transmission from a dry type unit mounted on a building floor may be transmitted through the building beams and cause bothersome conditions at some considerable distance away."

Two other basic disadvantages of the dry type transformer were cited "The first is that periodic internal maintenance is necessary to clean and blow off the precipitated air borne contaminants within the buildings and on the insulation surfaces before too great a build up results. . . . Second, if the unit is shut down or deenergized for any appreciable length of time, care must be taken to make certain that the insulation structure has not absorbed moisture or that condensation has not formed on external insulation creep surfaces, providing a leakage path in conjunction with precipitated contaminants on the surfaces. . . .

"From both a design and operating standpoint, the sealed dry type transformer is an ideal piece of equipment. It is hermetically sealed. No dust, dirt, contaminants, or moisture can enter the transformer case and insulation creepage clearances are not affected. . . . Therefore, the sealed dry type transformer should have an extremely long life with service reliability of the highest degree. . . . One disadvantage of the sealed dry type transformer is its higher initial cost, costing 20 percent more, on a base price basis, than an askarel filled or ventilated dry type unit. . . .

"Cost involves seven main factors of initial purchase price, installation cost, annual maintenance cost, annual cost of transformer losses, taxes,

Evening forum on industrial development of atomic energy was moderated by Sen. Bourke B. Hickenlooper, member of the Joint Committee on Atomic Energy.

insurance and depreciation. In cost considerations the life of each transformer type, in service, is considered equal provided that operating and loading conditions are similar."

Gas Turbines With Steam Plants

An interesting paper was delivered on the methods of combining the gas turbine cycle with the steam turbine cycle by utilizing three useful products from the gas turbine. These products are the mechanical shaft power, compressed air, and hot exhaust gas carrying a major portion of its original oxygen. The authors, W. B. Wilson and A. A. Hafer, both of General Electric Company, suggested four possible ways of combining the gas turbine with the steam plant. First, they suggested using the gas turbine exhaust to heat the feedwater for the steam plant.

Second, the gas turbine exhaust could be used to generate steam in an exhaust heat recovery boiler. Third, the gas turbine exhaust could be used as highly preheated combustion air for the boiler since it still contains over 80 percent of its original oxygen. Fourth, they suggested using the gas turbine compressed air in a supercharged boiler system with the exhaust of the gas turbine preheating the feedwater and/or the compressed air.

They observed "If the above combinations are effected properly, the efficiency of the combined plant will always be higher than either the steam cycle alone or the gas turbine alone. Where the gas turbine is used to heat the feedwater, this arrangement will replace feedwater heaters or economizer surface normally associated with steam plant."

They went on to say, "In the expansion and modernization of existing plants, or the design of new plants, the utilization of heat in the gas turbine exhaust for the generation of steam is another means of combining a steam and gas turbine for high overall power plant efficiency. Such combined plants are suitable for applications where electric power is the only desired product or in process plants where both steam and electric power are required."

The authors predicted that "Gas turbines will be used in a number of different types of combined steam-gas turbine plants. In the older medium-size steam plants (20,000 to 100,000 kw) simple-cycle gas turbines will find use with the exhaust used either to heat feedwater, or as highly preheated combustion air for the boiler. Selection of the method to use will be governed by the station conditions. If boiler capacity is the limiting factor, the exhaust will be utilized for feedwater heating; whereas, if steam-turbine capacity is limiting, the gas turbine exhaust will be used as combustion air for the fuel-fired boilers. Gas turbines will be used to drive boiler feedpumps or generators in large central stations (150,000 kw or larger) with the exhaust either heating feedwater or being used as combustion air in the boilers. In gas-burning steam plants, a flow-gas turbine combination is attractive with the exhaust also used as boiler combustion air. . . .

"For new medium-size steam plants, the gas turbine will provide all of the boiler combustion air or supercharge the boiler. In the larger new steam plants, the gas turbine will play an important future role in the supercharged boiler plant."

Power Distribution, A Fresh Look

Harry Decker, general superintendent of utilities, Electromotive Division, General Motors, had some potent comment to make. "We use three yardsticks to measure the efficiency of a power system. First, there are power losses; these may be important to the small plant, but in a large plant I feel they are of little importance because the other two get you into trouble before power losses are serious. Second, there is voltage regulation; here is one we could really get into an argument about. I do feel that the rapid growth in the use of electronic equipment is demanding better and better voltage regulators.

"Third, there is power factor, or rather, reactive kva. If your feeders and equipment are sized for some future growth, and therefore will take the additional current due to low power factor, there really is no need to take immediate corrective measures unless the power company billing forces you to do so because of brute economics.

"Maintenance provision. This is another item similar to reliability: the amount required depends on both the importance of shutdown to the manufacturing process and also on management policy. As a whole I feel that there is not enough attention paid to maintenance provisions when the distribution system is laid out: most designers seem to overlook the fact that after the system is working and their own job is done, the system reverts to some other poor individual who has to live with the system and make it work year after year. Anything that makes the individual's job easier and cheaper makes the system better suited for the plant."

Recover the Margin

In a paper with the interesting title of "Let's Take The Guess Work Out of Industrial Power Costs," F. B. Banton, consulting engineer, said "In the majority of plants, the largest single item of cost is the fuel cost. Also, in most plants, the biggest opportunity to effect savings lies in a more economical use of the utilities produced by the power plant. In general the overall efficiencies in the industrial power plants are good. . . .

"But, the fact remains, that regardless of the care and expense to maintain a high degree of efficiency and low cost in the power house itself, this efficiency can all be lost through careless and wanton waste by unnecessary use of the power plant services in the production areas. The establishment of a monthly heat balance and cost distribution system . . . . will provide the necessary control for reducing and maintaining the costs at the most economical point.

"This reduction in waste and careless use of these services — steam, air, refrigeration, electricity, etc. — can provide the additional margin in equipment and transmission capacity. This recovered marginal capacity often eliminates or at least postpones the purchase of additional capacity in the forms of equipment, or increase in pipe and wire sizes."

Steam Generator Standards

D. Cassino, design engineer at Foster Wheeler, reviewed the influence of design changes on costs of standard boilers. He said, "There are three major categories of standards prevalent in the boiler industry, each largely dictated by the capacity to be covered.

"Large central station units are usually developed to meet a set of custom conditions. . . . Medium and large industrial plants present less specialized problems. . . . In the smaller industrial plant, it has proven economically feasible to establish lines of completely designed (packaged type) steam generators."

He went on to point out that there is comparatively no room for flexibility in packaged boilers. Vertical and horizontal dimensions, drum diameters, firing equipment, and intimate accessories are all predetermined for a given boiler size. There are "handsome" compensations in drawing time, engineering, and delivery.

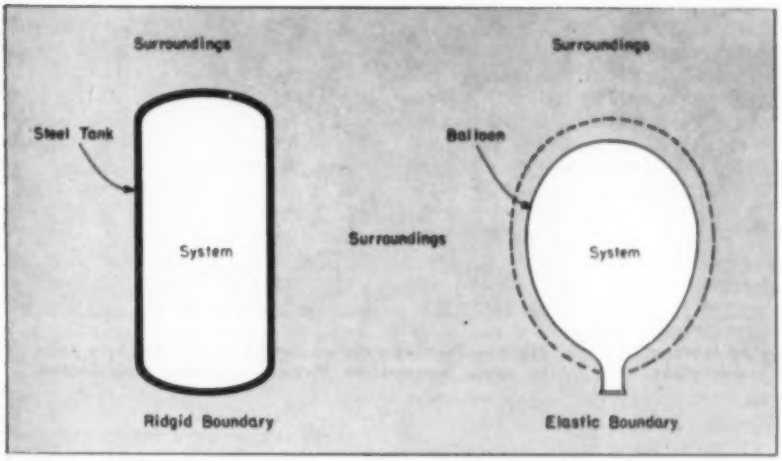


Fig. 1 — A thermodynamic system is confined within a boundary, real or imaginary, and rigid or elastic, which encloses it within the surroundings.

A Thermodynamics Refresher - I

The Basic Concepts and Definitions

I&P EXCLUSIVE

JOHN F. LEE
Professor of Mechanical Engineering
North Carolina State College

INDUSTRY & POWER begins a series of refresher articles on a fundamental subject—thermodynamics. Renew your understanding of the basic concepts that form the basis for many of industry's power services. The Thermodynamics Refresher will continue monthly. Additional single copies are available gratis.

THERMODYNAMICS is firmly rooted in two basic principles known as the First and Second Laws of Thermodynamics. Out of these two laws grows a large number of concepts that constitute an important concentration of facts to be remembered and understood. The difficulties ordinarily met in the study of any such science disappear when the meanings of the terms are clearly understood.

We can define a thermodynamic *system* as a definite quantity of matter confined within a specified *boundary*. Everything interacting with the system but lying outside the boundary is called the *surroundings*. This boundary itself may be real or imaginary, rigid or elastic. For example, a heavy steel tank enclosing a quantity of gas (Fig. 1a) is a real and rigid boundary. The gas is the system. A rubber balloon containing a gas (Fig. 1b) is a real and elastic boundary. Similarly, a cylinder containing a gas and equipped with a movable piston is an example of a real and elastic boundary.

Open and Closed Systems

Systems may be further described as being *open* or *closed*. An open system experiences a flow of matter across its boundaries. A closed system contains a constant quantity of matter with no transfer of matter.

A very practical example of a thermodynamic system is the steam that flows through the components of a steam power plant. The steam constitutes a closed system if we disregard leakage, makeup, and blowdown. The walls of the boiler tubes, condenser tubes, pipes, and turbine casing constitute the boundary of the system (Fig. 2). The atmosphere, condenser circulating water, and the products of combustion in the steam generator comprise the surroundings.

The *state* of a system is specified in terms of its *properties*. Conversely, we may say that the properties of a system do not change so long as the system remains in a specified state. Suppose, for instance, that a system consists of a gas confined in a tank. Then its state is completely specified by giving its pressure, volume, temperature, and the weight of gas. (Since the gas in one part of the cylinder is considered to be in the same state as the gas in any other part, the properties of the gas can be expressed in terms of standard, basic units of volume.)

Relationship of Properties

We know that a definite relationship exists between the pressure, the volume, and the temperature of any thermodynamic system. This relationship is expressed as $pv = RT$

where p = pressure
v = volume
R = constant
T = temperature

Now, because the state of a system is defined by the values of its properties and because we have a defining relationship between these properties, the state of any system may be completely specified by any two of these properties. For example, if the pressure and temperature of the gas in a system are measured, we can calculate the volume. Only two out of the three properties (pressure, volume, and temperature)

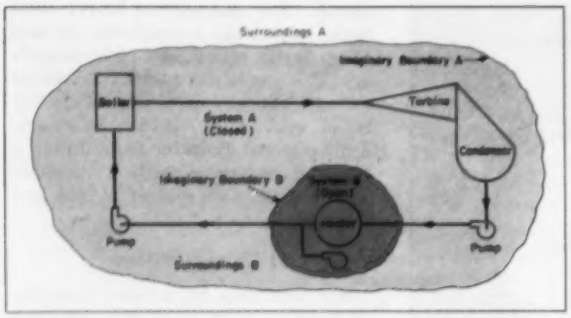


Fig. 2 — An example of a thermodynamic system is steam flowing through components of a steam power plant.

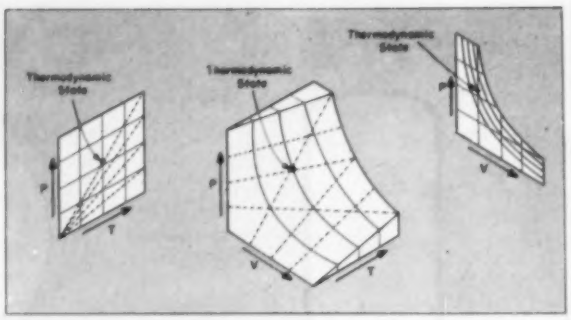


Fig. 3 — State of a system can be represented by a point in space relative to three rectangular coordinates.

need be specified to completely determine the state of the system.

We can now see that the state of a system is represented by a point in space (Fig. 3) relative to three rectangular coordinates — pressure, volume, and temperature. The projection of this point on any of the three planes (P-V, T-V, or P-T) is itself a point. Therefore, we refer to the system properties as point functions. That is, the properties themselves are the coordinates locating a point that defines the state of the system. For this reason, in fact, thermodynamic properties are often referred to as *thermodynamic coordinates*.

A substance may exist in one of three *phases* (*solid*, *liquid*, or *gas*) or in two-phase mixtures. If a block of ice, for example, is heated it will melt and then vaporize into steam. Two-phase mixtures of steam and water at the boiling point (or saturation temperature) occur in all steam power plants.

Properties Not Independent

The important thing is that the properties of temperature and pressure are not independent when a change of phase is taking place. Hence, the state of a system consisting of a two-phase mixture must be specified in terms of independent properties such as pressure and specific volume, or temperature and specific volume. The state of the system also can be specified (as we shall see later) in terms of either pressure or temperature plus the quality, or composition, of the two-phase mixture.

When a system undergoes a change of state (that is, when the values of any or all properties change), the occurrence is known as a process. To fully understand the process, the behavior of the system during the change of state must be specified. This behavior may take an infinite variety of forms, but we need only consider the constant-pressure, constant-temperature, and constant-volume processes plus two others. One of these involves no work (called a *no-work* process) and one involves no transfer of heat (called an *adiabatic* process). It is particularly important to understand that the system properties are a function of the state of a system, and that they do not depend on the particular process followed to achieve that state.

Forms of Energy

Energy may be classified into two categories. One category is energy (sometimes called stored energy) that is characteristic of a system. The other category is energy that is characteristic of a process (called transitory energy). Each category has properties of its own. The (stored) energy of a system is comprised of internal energy (u), flow energy (pv), kinetic energy ($V^2/2g$), potential energy (l), and chemical energy. The (transitory) energy of a process is comprised of heat energy (q) and work (w).

Internal energy is present in a system because of the motion and relative position of the molecules and atoms. Internal energy is a property of the system and is therefore a function of the state of the system. It is also, therefore, a function of the properties of pressure, temperature, and volume.

Flow energy is the energy of a system that must be expended to introduce a given quantity of substance into another system (when flow takes place). Since flow energy is composed of the two properties, pressure and specific volume, it is itself a property. The sum of the internal energy and flow energy, u + pv, is called *enthalpy* (h) for convenience.

Kinetic energy is the energy possessed by a system by virtue of its being in motion. *Potential energy* is the energy in a system by virtue of its position relative to some datum. *Chemical energy* is that energy possessed by a system that can be released as a result of chemical reaction.

Work

All the foregoing forms of energy can be stored in a system. Let us turn now to the question of how energy can be transferred from one system to another. While energy is in transfer, we cannot in any sense regard it as being stored energy. It is necessary, therefore, to conceive of the transitory forms of energy. One important form of transitory

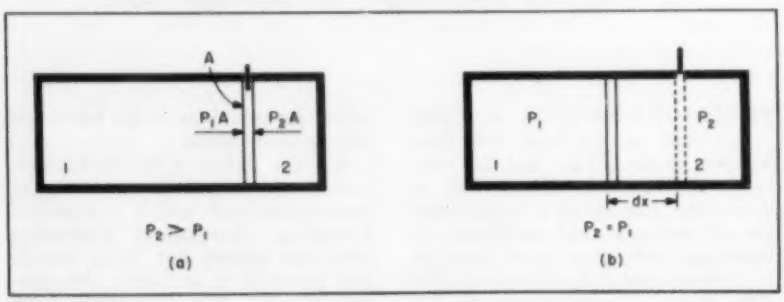


Fig. 4 — Piston is locked in position in the cylinder with a removable pin.

energy is work. *Work* is done when a force acts through a distance. Work is defined as the multiplication (product) of a displacement by the amount of force exerted in the direction of that displacement. Work can always be expressed simply as the product of displacement and the component of force producing the displacement. We shall find it more convenient, however, to associate work with a change in volume.

Consider the work done in the expansion and compression of a gas. Fig. 4a shows a cylinder equipped with a piston that is locked in position by means of a pin. System 1 consists of a gas at pressure P_1 and System 2 consists of a gas at a higher pressure P_2. If we designate the area of each face of the piston as A, then the forces on the two sides of the piston are P_1A and P_2A. The force on the right side of the piston is greater than that exerted on the left side, favoring movement of the piston to the left were it not for the fact that the piston is locked in place. No work is done regardless of the forces that are maintained since there is no piston displacement.

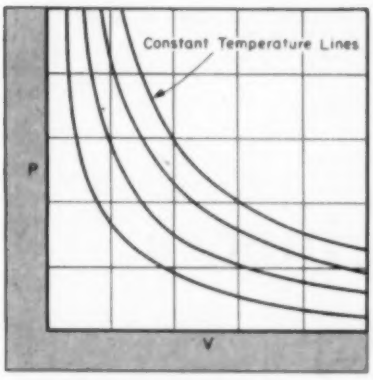


Fig. 5 — No change in temperature is shown by this P-V diagram

If we remove the pin the piston will move to the left. We shall assume the movement is frictionless and note that the piston will continue to move until the forces on the two faces of the piston are balanced. Since the areas of the piston faces are equal, this is equivalent to saying that the piston will move until the pressures of System 1 and of System 2 become equal to each other as shown in Fig. 4b. We note that since the piston is displaced because of a net force to the left, work is done.

It is important to understand that the pressures P_1 and P_2 are not necessarily constant. In this case, the net pressure moving the piston is actually the difference between the pressures of the gases on the two sides of the piston, a difference that decreases as work is done. The pressure difference ultimately becomes zero, the piston stops moving, and work ceases to be done.

We may view the work done from the standpoint of either System 1 or System 2. In the case of System 1, the gas is compressed and its volume is decreased. Therefore, the work done by System 1 will be a negative value. We say, then, that work has been done *on* the system because the work is negative. On the other hand, the gas in System 2 expands and its volume is increased. This work is positive. We say, therefore, that the work done *by* the system is positive.

The behavior of pressure and volume in the foregoing paragraphs included no change in temperature. This may be shown graphically as the curve in a P-V diagram (Fig. 5) in which the curve's path stays in one P-V plane. But any number of alternate paths (Fig. 6) can be followed in changing the state of a system from Point 1 to Point 2. The work done is indicated by the area under the curve representing the particular path taken by the process, so that the amount of work done is dependent on the path. Work, therefore, is a *path function*. To evaluate the amount of work done, the path of the process must be specified.

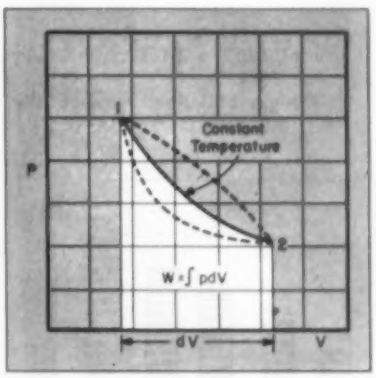


Fig. 6 — Several paths can be followed in changing system's state.

Since work is a *path function* and not a *point function*, it is meaningless to speak of the "work of a system." Work exists only in a process that changes a system. Similarly, heat is a transitory form of energy and is also a path function. It is just as meaningless to speak of the "heat of a system" as it is to speak of the "work of a system."

Heat

Heat is defined as *energy in transfer* from one system to another, the transfer being due to a temperature difference between the systems. When two systems at different temperatures are placed in direct contact, heat flows from the system of higher temperature to the system of lower temperature by the mechanism called *conduction* (Fig. 7a). Heat may also flow between two systems separated by empty space via electromagnetic waves. This is the mechanism called *radiation* (Fig. 7b).

A third mode of heat transfer between systems is *convection* (Fig. 7c). In the transfer of heat by convection, heat flows from a hot body to a fluid by conduction, the fluid moves from the hot body to a cold body, and the heat then flows from the fluid to the cold body by conduction. This combined conduction-flow-conduction mechanism is convection.

The phenomena of heat flow are properly a part of the science of heat transfer. It is sufficient, for the present, to recognize that energy in the form of heat flows between systems because of tempera-

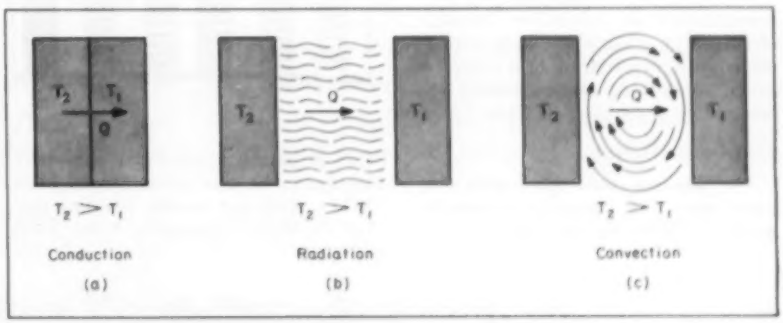


Fig. 7 — Three modes of heat transfer — always from hotter to cooler system.

ture differences between the systems and that it flows toward the body at the lower temperature.

Specific Heat

The *specific heat* of a substance is the amount of heat that must flow to one pound of that substance to increase its temperature one degree Fahrenheit. By the same token, the specific heat also can be defined as the amount of heat that must flow from one pound of a substance to decrease its temperature one degree Fahrenheit. The magnitude of the specific heat depends on the individual characteristics of the particular substance and on its temperature and pressure.

From these definitions, it is clear that the amount of heat flowing to or from a substance may be expressed in terms of temperature change, the specific heat, and the weight of the substance. For most practical cases, the weight involved is constant. The heat flow can then be expressed as $Q = m\, c_n\, (t_2 - t_1)$.

where Q = quantity of heat
m = mass of the body
c_n = specific heat of the substance involved (a mean value of c_n that is appropriate to the temperature range involved)
t_1 = temperature at the beginning of the process
t_2 = temperature at the end of the process.

We already have noted that heat is a path function. Like work, the amount of heat flow depends on the path by which the temperature change in the substance takes place. Two paths are of special interest to us, namely, a change in temperature with pressure constant and a change in temperature with volume constant. The specific heats for these two special cases are designated by the subscripts p and v to indicate constant pressure and constant volume respectively. Accordingly, the foregoing equation is written

$Q_p = m\, c_p\, (t_2 - t_1)$ — constant pressure, and

$Q_v = m\, c_v\, (t_2 - t_1)$ — constant volume.

Next Month: Another article in INDUSTRY & POWER's *Thermodynamics Refresher. Prof. Lee will write about "The First Two Laws."*

Starting Salaries For Engineers Are Still Going Up

STARTING SALARIES for beginning engineers have reached an all-time high according to Illinois Institute of Technology, Chicago.

A survey of the January graduating class at Illinois Tech. shows that engineers receive an average starting salary of $383 per month. This is $10 more than a year ago — the previous high.

Reason is Shortage

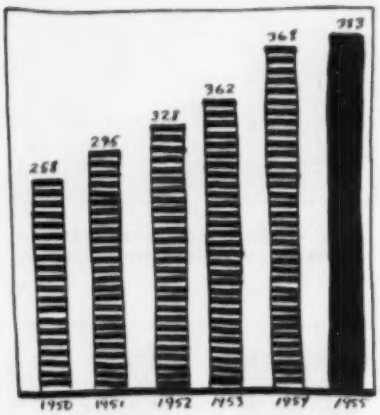
The increase is attributed to the nation's shortage of technically-trained personnel. The situation is such that many employers no longer are paying attention to a graduate's draft status.

A record 200 companies sent representatives to interview January engineering graduates. Each graduate was interviewed by an average of seven companies, approximately the same ratio as for the past three years.

Chemicals Highest

The highest paid graduates this year were the chemical engineers, who received an average starting salary of $398, a $4 increase over January 1954.

The biggest dollar increase occurred in the mechanical engineering field where salaries jumped from $370 to $392 per month. Starting pay for electrical engineers went from $367 to $386 and for industrial engineers from $350 to $353.



The only decline was in the civil engineering field where starting salaries dropped from $388 in January 1954 to $378 this year. The drop in civil engineering was influenced by a 90 percent participation in the job survey by January civil engineering graduates. Only 60 percent took part last year.

Average is High

The January 1955 average of $383 for all engineering fields was an increase of $20 over the average starting wage for the June 1954 class.

Averages, based on the starting salaries of combined June and mid-year graduating classes, have increased every year since 1950 when the average was $258. In 1951 it jumped to $295; 1952, $328; 1953, $362; 1954, $368. This year's figures are for students receiving a Bachelor's Degree and planning to work a 40-hour week and are based on reports from 74 percent of the engineering graduating class of 95.

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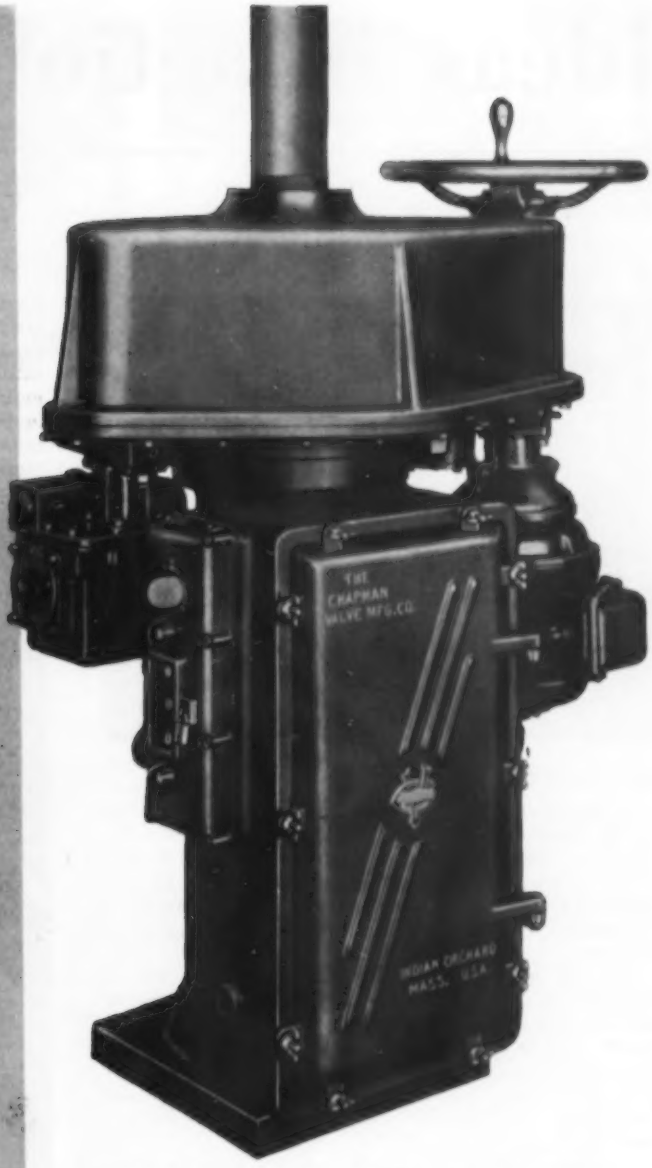

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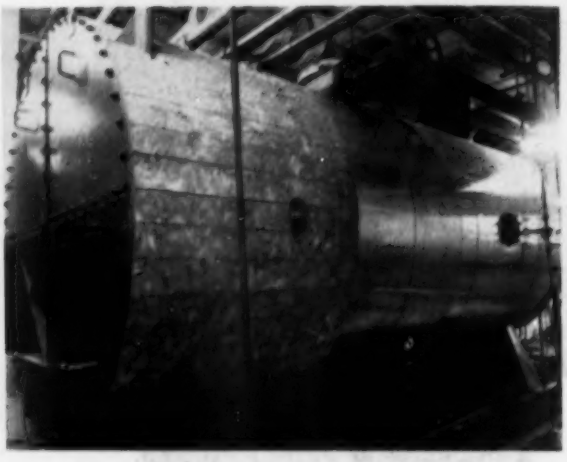


New Trick For Insulating Boilers

A new technique for insulating boilers was used in the recent installation of a 400-hp steam generator. The technique essentially consists of applying a layer of preformed Fiberglas insulation and sheathing it with 20-gauge aluminum. The result is a job that requires no maintenance and that retains a clean appearance indefinitely.

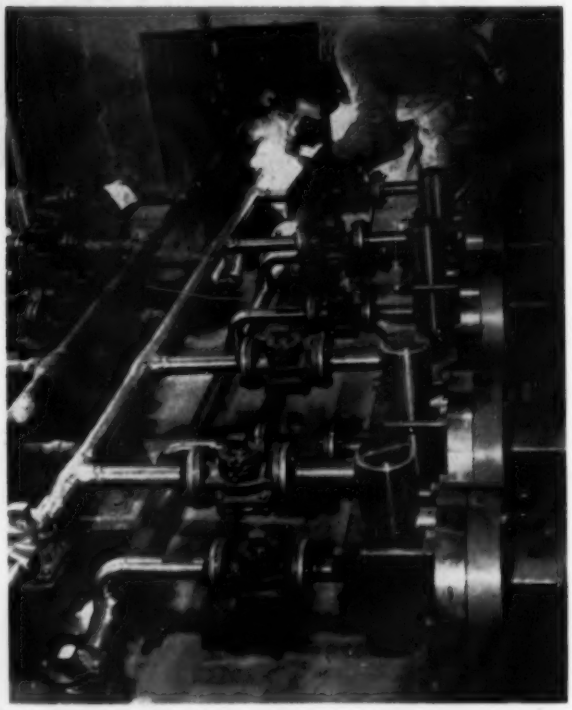
One day was required to put the two-inch blocks of Fiberglas in place. They are secured with wire cables. Another two days were needed to install the aluminum sheath. The total area covered was 401 square feet. The insulation was applied as soon as the boiler was set in place, before any piping was installed. Holes were then cut through the Fiberglas-aluminum covering to accommodate all piping.

It is claimed that this type of insulation costs no more than the conventional asbestos-portland cement finish. The principal advantages are ease of cleaning, permanent finish that needs no painting, and extra protection afforded the insulation by the metallic sheath. The insulating system was developed by Cleaver-Brooks and Aljon Manufacturing Company.

Stainless Steel Pipe Makes News

Stainless steel piping is being used at General Electric's Appliance Park, Louisville, to carry large quantities of nitric, sulfuric, and phosphoric acids from tank farms to work areas. The piping runs under ground and above ground to feed cleaning and pickling operations. The stainless steel piping provides adequate and economical protection against the severe corrosion conditions that exist. Design pressure of the piping system is 100 psi. Operating pressure is 60 to 68 psi.

The company formerly had employed carbon steel, wrought iron, stainless steel, aluminum, and lined piping. Among the advantages cited for the new plastic piping are its lower initial cost, elimination of failures and downtime, reduction in inventory of replacement pipe and fittings, elimination of hazards and waste accompanying piping failures, elimination of scale formations inside piping (stopping pressure losses due to buildup of corroding internal surfaces), and elimination of contamination of the reagents being handled.



Plastic Pipe Makes News

Among the first large-scale handlers of highly corrosive liquids to switch from metal to plastic piping for all services is the Globe Chemical Company of Cincinnati. They have switched to polyvinyl chloride to handle 77- to 96-percent sulfuric acid, 61.4-percent nitric acid, 37- to 38.5-percent muriatic acid, 75- to 85-percent phosphoric acid, and 99.5-percent glacial acetic acid. Temperatures are atmospheric. Pressures do not exceed 100 psi. Piping ranges from 1.25-inch to 2-inch diameters.

Three New York's in Water

Pumping capacity adequate to supply the average daily consumption of three cities the size of New York has gone

(Continued on page 67)

HOW TO KEEP PRODUCTION UP!

A few generations ago, John Ruskin had a few penetrating remarks to register on business—and what he said makes a lot of sense today.

"The common law of business practice," he commented, "prohibits paying a little and getting a lot. If you deal with the lowest bidder, it's well to add something for the risk you run. And if you do that, you will have enough left over for something better."

Let's translate this in terms of furnace construction for refineries. If you buy a heat enclosure for a job where high and continuous production is a must, then it's imperative that you invest in one that will stand the gaff. To make sure, you've got to build a unit which is properly engineered for the job it must do. You pay more, of course. But it's poor economy—and often embarrassing—to plow money back into repairs right at the peak of production.

That's all we have to say. You get sound engineering and a job designed to stay on stream when you come to Bigelow-Liptak. We've been designing refinery furnaces for years—erecting them, too. Both suspended and castable construction—the one that's best for the job—are used. Better investigate—right now!

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into service in the Florida Everglades. Six 116-inch Fairbanks-Morse pumps with a combined capacity of more than 3 billion gallons a day have been installed as the heart of a gigantic water control system that promises to tame the flood waters of the Everglades and to reclaim millions of acres of rich farm land.

Power for each pump is delivered by a 1600-hp Fairbanks-Morse opposed-piston diesel, which enables the installation to function even during hurricanes when electric power lines are down. This is the world's largest self-powered pumping station.

Three Miles in Four Directions

It might be expected that the nation's largest electric power producing steam plant—TVA's Shawnee Steam Station—would have something unusual in the way of coal-handling facilities. This is exactly the case. A network of nearly three miles of rubber conveyor belts, operating in four directions at once, can handle 1400 tons of coal an hour. The entire coal-handling system is controlled at a graphic panel (see INDUSTRY & POWER, March 1955, p 52). The panel shows the status of coal flow from barge docks, car dumpers, stock pile area, and crusher building.

Some 14,000 tons of fuel a day are handled for the ten 150,000-kw generating units. The conveyor system

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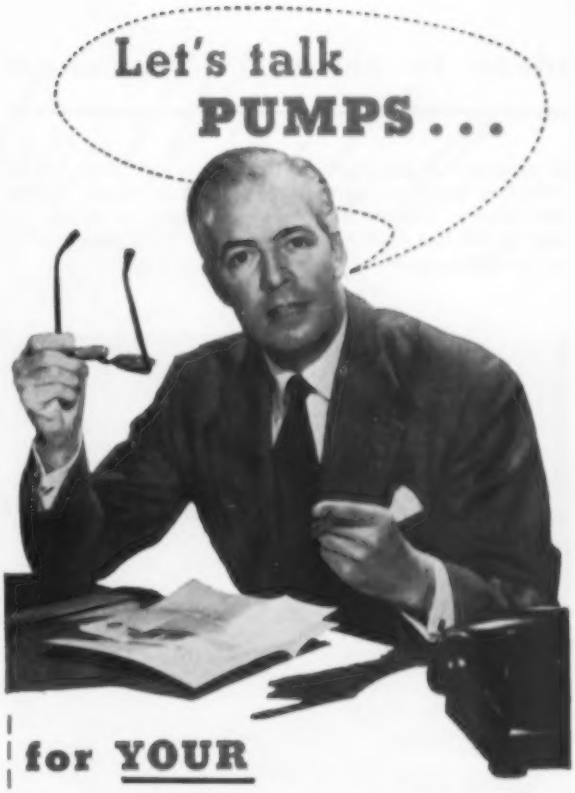

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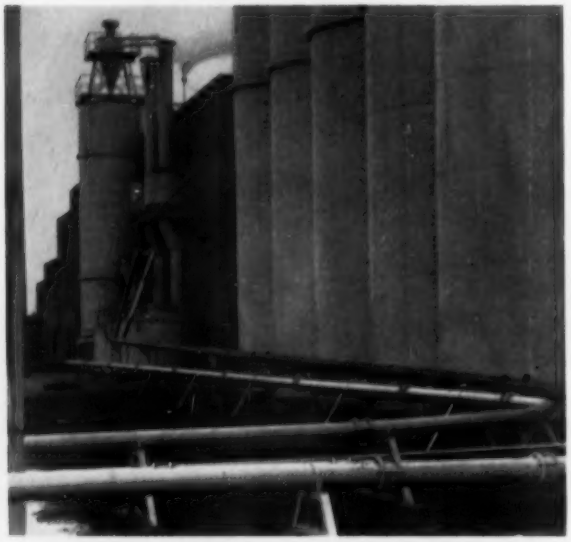
is comprised of ten flights, ranging in length from 200 to 2640 feet. Belts are as wide as 54 inches, handle up to 1200 tons of coal an hour each, and move at speeds as high as 480 feet a minute. Three of the belts carry loads up 16-degree inclines.



Bear Beer Grains on Air

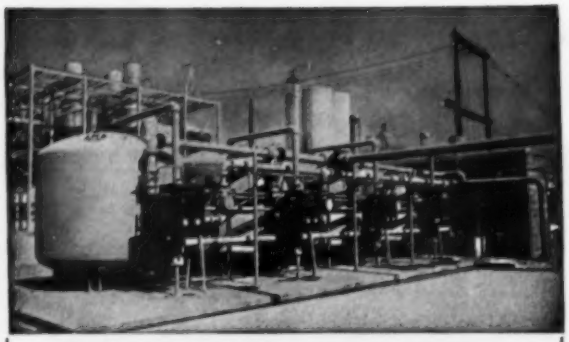
Carrying bulk materials on an air stream in a midwest brewery is helping double the annual output of beer there. Malt is unloaded from boxcars at the rate of 18 tons an hour and cereal is unloaded at a rate of 13 tons an hour via "Airstream" conveyors. The "Airstream" conveyors also transport material from primary storage to process, transport spent grain into boxcars, and collect spent grain dusts for further use. The entire handling operation is controlled from a single panel operated by one man.

Principal advantages of the system are these: Ease of loading and unloading boxcars permits economical bulk purchasing. Vertical conveying operates at the same air pressure as horizontal conveying so that the system is quickly adaptable to practically all plant structures. The enclosed contamination-free system eliminates metal-to-metal contact and the problem of metal filings. Finally, the system is selfcleaning.

Standby for Natural Gas

Even in the areas where natural gas is plentiful, supply interruptions can occur. Industry must maintain adequate gas supplies during interruptions in the natural gas service. At Ford Motor Company's Milpitas, California plant, the natural gas service is backed up by a standby LP-gas system designed and installed by American Liquid Gas Corporation. The standby system has a storage capacity of 180,000 gallons, divided among six 30,000 gallon tanks. The six tanks are arranged in two banks of three. There are three tank

(Continued on page 85)



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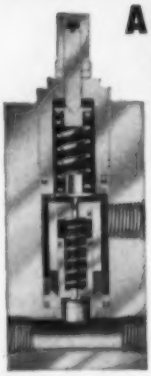
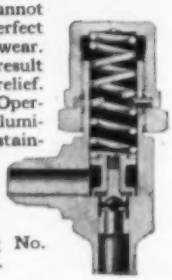


A guided piston that cannot get out of line assures perfect sealing, and long seat wear. High quality springs result in permanent, accurate relief. Angle, In-line, and Pilot Operated. Made in brass, aluminum alloy, steel, and stainless steel. Sizes ⅛" to 2" pipe, AN, or JIC connections. Other sizes and materials to order.



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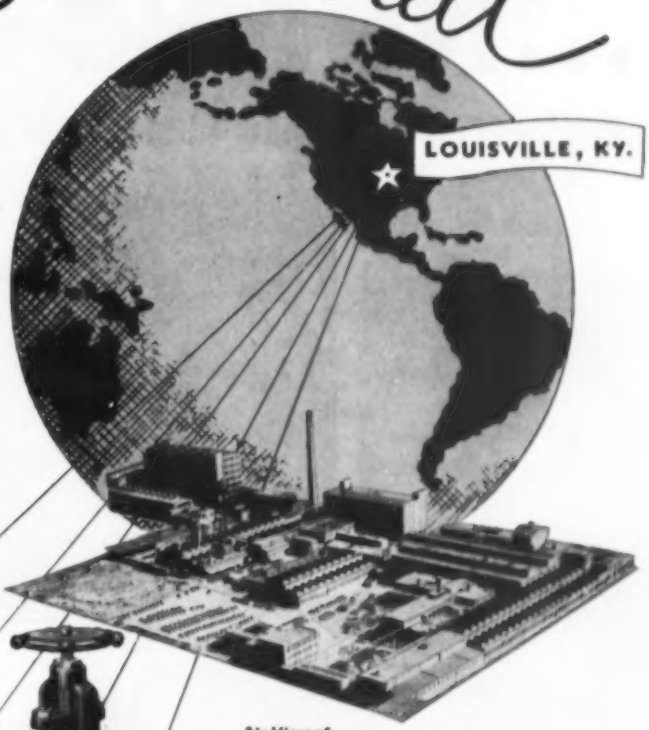
DROP FORGED STEEL

VALVES, FITTINGS and FLANGES

by

Vogt



Air View of
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This 24 acre Vogt plant supplies the most comprehensive line of top quality *drop forged* steel piping materials anywhere available to industry. That's why they're the choice of leading refineries, power plants, chemical plants, etc., the world around!

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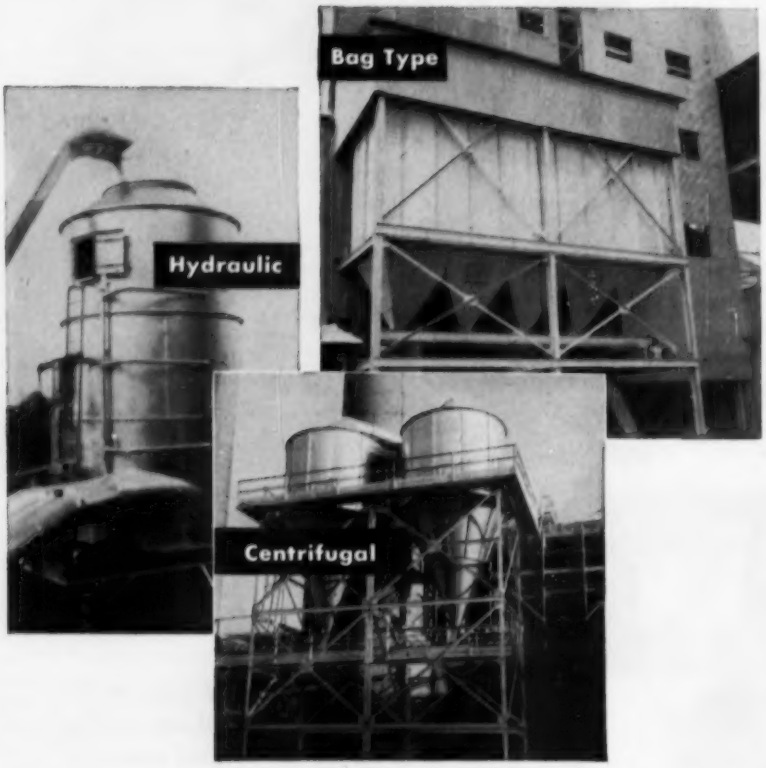
Use this valuable aid to safety, health, operating economy

...Norblo

engineered Dust and Fume Collection



Any dust condition can increase operating and maintenance costs, slow down employee performance and increase industrial accidents. Norblo helps you to achieve outstanding efficiency in dust and fume collection—helps you to avoid those costly factors *economically*.

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Engineered Dust Collection Systems for All Industries

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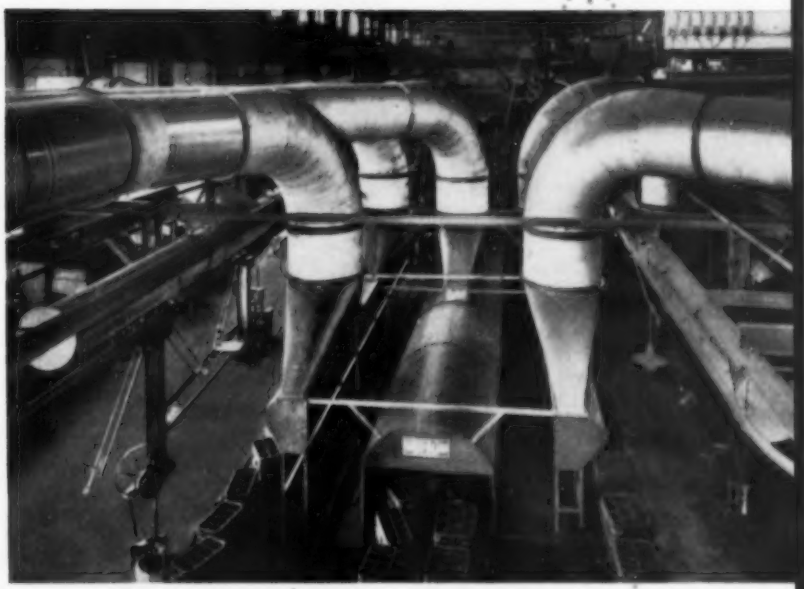


Fumes are really given the air at G.H.R. Foundry, Dayton, O., where Kirk & Blum installation serves 4 pouring lines

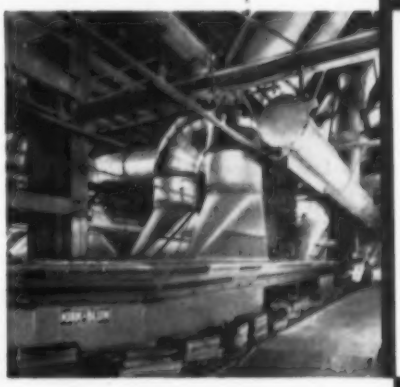
A 260,000 C. F. M. exhaust system whisks fumes, smoke, and gases from four pouring lines and two Kirk & Blum smoke tunnels. Offset exhaust stacks clear overhead cranes. A separate 60,000 C. F. M. supply system furnishes outside air for man cooling at the pouring lines.

This installation at G. H. R. Foundry, Dayton, Ohio, typifies Kirk & Blum's complete service: Design, Fabrication, and Installation of Dust and Fume Control Systems.

Let Kirk & Blum design a system specifically engineered for conditions in your foundry. Put "Clean Air . . . the Invisible Tool" to work in your plant.

Write today outlining your fume and dust problems.

Fume exhaust system and forced air cooling of working area



Core cooling, fume exhaust and worker cooling arrangement

THE KIRK & BLUM MANUFACTURING CO.
3174 Forrer Street Cincinnati 9, Ohio

KIRK & BLUM
FUME AND DUST CONTROL SYSTEMS

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names make news

. . . personalities from industry and power

WESTINGHOUSE ELECTRIC CORP. announces that its wholly-owned subsidiary SCHNEIDER MFG. CORP. is dissolved to form the Hydraulic Drives department of WESTINGHOUSE GEARING DIVISION.

AMERICAN SOCIETY OF TOOL ENGINEERS has elected new officers. President is DR. HARRY B. OSBORN, JR., Ohio Crankshaft Co. First vice president is H. C. MCMILLEN, Philco Corp. Second vice president is H. E. COLLINS, Hughes Tool Co. Third vice president is R. C. W. PETERSON, Peterson Engineering Co. Fourth vice president is WAYNE EWING, Arrowsmith Tool and Die Co., Inc. Treasurer is HAROLD D. LONG, Scully-Jones & Co. Secretary is JOHN X. RYNESKA, General Electric Co.

Stewart

Miller

DELAVAL STEAM TURBINE CO. advises J. P. STEWART, president of DeLaval, is elected a board member of the National Industrial Conference Board for a one-year term.

JOHNSTON PUMP CO. announces appointment of A. H. MILLER, vice president of Emsco Mfg. Co., as Johnston's general manager. Emsco acquired the assets of Johnston Pump Co. in January.

BABCOCK & WILCOX CO., TUBULAR PRODUCTS DIV. announces promotion of GEORGE W. KROSS, JR. to superintendent of the division. CARL J. STOOPS is named assistant superintendent.

NIAGARA BLOWER CO. has elected MARTIN H. OLSTAD as vice president in charge of engineering and WILLIAM M. MOSLER as secretary.

FEDERAL PACIFIC ELECTRIC CO. appoints CHARLES A. SCHMIDT as product sales manager for AB breakers.

INTERNAL COMBUSTION ENGINE INSTITUTE has a new president. He is B. G. VAN ZEE, chief engineer, Automotive Engineering Div., Minneapolis-Moline Co. Vice president is E. DON TULL, Cummins Engine Co., Inc. Secretary is H. W. SMITH, Caterpillar Tractor Co. and treasurer is PHIL NORTON, Wisconsin Motor Corp.

WORTHINGTON CORP. appoints J. A. KLAIBER as St. Louis district supervisor of the Air Conditioning and Refrigeration Div.

ELECTRIC AUTO-LITE CO. announces three promotions. RALPH A. STUEDE becomes assistant general purchasing agent of the company's Battery Div. W. H. SUDDATH becomes purchasing agent of the Vincennes, Ind., battery plant. MAX O. MARTIN is now purchasing agent of the Wire and Cable Div.

BYRON JACKSON CO. has elected these four men as vice presidents. NORMAN D. JESSE is in charge of sales, service, and branches of the Pump Div. BARTH F. NICOLSON becomes vice president in charge of the Oil Tool Div. EVAN H. SWEET is appointed vice president and counsel, and ROSS BARRETT is made vice president in charge of public relations, advertising, and market research.

INTERNATIONAL NICKEL CO., INC. announces KENNETH A. DELONGE is now in charge of the Iron and Non-Ferrous Castings Section of the Development and Research Div.

COOPER-BESSEMER CORP. has promoted ROBERT F. LAY to general sales manager. GRANT C. WOODARD is assistant general sales manager.

A. M. BYERS CO. announces appointment of V. C. LAWRENCE as manager of the New York Div. and A. N. VORIPAIEFF as manager of the Marine and International Div.

DRAVO CORP. announces its appointment as exclusive distributor of PARACOIL heat transfer equipment through its Pittsburgh, Cleveland and Detroit offices.

ROCKWELL MANUFACTURING CO. announces the retirement of CHARLES B. JOHNSON, consulting engineer and former chief engineer of several Rockwell divisions, after 44 years in the engineering field.

BROWN BOVERI CORP. stockholders have voted to acquire the assets, goodwill, and technical background of STOCKWELL TRANSFORMER CORP. of Akron, Ohio.

THE LINCOLN ELECTRIC COMPANY has appointed L. K. STRINGHAM as vice president in charge of engineering. He has been chief engineer for the company since 1951. GEORGE LANDIS who has been engineering vice president was appointed vice president in charge of research.

SANTA FE TANK & TOWER CO., INC. announces appointment of JAMES G. DE FLON as chief engineer in the Cooling Tower Division.

AMERICAN LOCOMOTIVE COMPANY has appointed JOHN F. HAINES, formerly vice president and chief engineer of the MCCAULEY INDUSTRIAL CORPORATION of Dayton, Ohio, as chief development engineer, Atomic Products.

RESEARCH-COTTRELL INC. announce that CHARLES E. BEAVER, general sales manager has been elected a vice president and SCHAEFFER E. SPECHT, formerly sales engineer becomes assistant sales manager.

AMERICAN BRAKE SHOE COMPANY announces new executive appointments in two divisions. JOHN S. HUTCHINS becomes president of the National Bearing Division, THOMAS W. PETTUS is assigned to overall railroad sales and CHARLES M. RUPRECHT president of Electro-Alloys Division becomes executive vice president of National Bearing Division.

ALLIS-CHALMERS announces that ROBERT S. STEVENSON has been elected president to succeed the late WILLIAM A. ROBERTS. R. H. GODEKE has been appointed manager of the new General Machinery Division branch office in Corpus Christi, Texas.

NATIONAL ALUMINATE CORPORATION recently announced the advancement of former assistant vice presidents H. R. POWERS, GAGE AVERILL and ALPHONSO CANTALINI each to the post of vice president. Other Nalco promotions include those of H. E. BERG, W. H. THOMPSON and A. O. JAROS to assistant vice presidents.

GENERAL ELECTRIC COMPANY has appointed ARTHUR H. SISSON as manager of Advance Engineering and RICHARD A. BAKER as Engineering Administrator.

CHRYSLER CORPORATION announces that JEREMIAH M. SULLIVAN has been appointed coordinator of organization, management, executive development, and industrial education for its Defense Operations Division.

THE TRANE COMPANY has elected R. JAMES TRANE, WAYNE J. HOOD, THOMAS J. HANCOCK as executive vice presidents and RICHARD H. PEARSE, SR. as vice president.

Boiler Refractories

Bulletin R–36

CONTENTS:

How important are Refractories?
Discussion of basic requirements of refractories and critical refractories areas in boilers.
PAGE 3

What causes Refractories to fail?
Includes discussion of hot load strength, spalling, shelling, slagging, abrasion, erosion, shrinkage and expansion.
PAGE 5

Description and Properties of:

FIREBRICK PAGE 7
INSULATING FIREBRICK PAGE 9
REFRACTORY CASTABLES PAGES 11 AND 13
REFRACTORY PLASTICS PAGES 14 AND 15
REFRACTORY MORTARS PAGES 14 AND 15

Marine Boilers
PAGES 16 AND 17

Ashpit Refractories
PAGES 18 AND 19

New 20-page Handbook

FOR SELECTING BOILER REFRACTORIES

Contains detailed discussions of critical refractories areas in both refractory-lined and water-cooled boilers. Your local B&W Representative will be glad to send you a copy. Just ask for Bulletin R-36.

The Babcock & Wilcox Company

Refractories Division
General Office: 161 East 42nd Street, New York 17, N.Y.

B&W REFRACTORIES PRODUCTS: B&W Allmul Firebrick • B&W 80 Firebrick
B&W Junior Firebrick • B&W Insulating Firebrick • B&W Refractory Castables, Plastics and Mortars
OTHER B&W PRODUCTS: Stationary & Marine Boilers and Component Equipment
Chemical Recovery Units • Seamless & Welded Tubes • Pulverizers • Fuel Burning Equipment
Pressure Vessels • Alloy Castings

BABCOCK & WILCOX

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R-930

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for YEARS of low cost steam

Get the complete story. Write for Catalog 702 describing 18 sizes from 20 to 600 b.h.p; pressure to 250 p.s.i. burning oil or gas or both.

Boilers, too, grow old ... and when the honeymoon of the first year or two is over, dirt, scale, and wear on moving parts start to take their toll in loss of efficiency. That's why Superior Steam Generators are built bigger, heavier, and more rugged, with four-pass construction and full 5 sq. feet of heating surface per boiler horsepower, measured on the smaller I.D. of the tubes. The relatively slow speed full bank induced draft fans, the larger triple-blow-down water column, and the rigid channel iron base are other typical features of design which add the stamina that makes efficient low cost steaming a reality ... not for a year or two; but throughout the long life of the unit.

for performance you can **BANK** *on*

SUPERIOR
STEAM GENERATORS

SUPERIOR COMBUSTION INDUSTRIES INC.
TIMES TOWER, TIMES SQUARE, NEW YORK 36, N.Y.

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readers' guide

. . . industry & power's advertised products

The table below lists, according to product groupings, all equipment advertised in this issue. To request more data, circle key numbers on reply cards, pages 34 and 74.

Key No.	Advertiser	Product	Page No.
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556	Cleaver-Brooks Co.	Self-contained boilers	91
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542	Engineer Co., The	Oil burners	80
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550	Johnson Corp., The	Condensate return system	86
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509	National Coal Association	Coals	19
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bulletins

. . . for industry & power

AIR CLEANING & DUST COLLECTION

250—Dust Collection Manual

"The Collection and Recovery of Industrial Dusts," 32-page manual 101, discusses various types of dust and techniques used in analysis, lists the factors which influence choice of equipment, and explains operation. Buell Engineering Co., Inc.

252—Using Dust Collectors

Dust collectors, including cyclone, wet or dry dynamic, and cloth screen arrestor types are the subject of a 32-page bulletin. Uses of air conditioning, ventilating, conveying, drying, and cooling units are presented. Kirk & Blum Mfg. Co.

253—Dust Collectors and Arrestors

Series of four folders describes cyclone type collector and portable, standard, and automatic bag-type dust arrestors. Also includes 32-page catalog describing exhaust fans for dust collecting and air handling. Northern Blower Co.

AIR CONDITIONING-HEATING & REFRIGERATION

254—Answers to Hot Water

Answers to your hot water problems are given in booklet "Methods and Means." Operation and advantages of the instantaneous water heater as compared to the indirect method heater are discussed and illustrated. Pick Manufacturing Co.

256—Heat Exchanger Operation

Air-flow diagram in two-page data sheet 124 shows graphically operation of the Aero Heat Exchanger for water, oil, or compressed air cooling. How the unit saves cooling water, piping, pumping, and equipment costs is explained. Niagara Blower Co.

257—Specifying Liquid Receivers

"Liquid Receivers for Ammonia and Freon," 4-page bulletin LR-1, gives all the information necessary for specifying these units and includes elevation drawings to show typical installations. Henry Vogt Machine Co.

BOILERS & STEAM

258—Water-Tube Generator Specs

Completely packaged Water Tube Type D Superior Steam Generators in 17 sizes, with capacities from 8000 to 40,000 lb of steam per hr, are described in detail in eight-page catalog 5M-54. Superior Combustion Industries, Inc.

259—Versatility of Spreader Stokers

Spreader stokers said to be adaptable to all types and makes of modern steam boilers and generators, from 5000 to 75,000 lb per hr steam output capacity, are described in 14-page brochure 800. Various installations using Roto-Stoker Type CC stokers are shown. Detroit Stoker Co.

268—Latest in Underfeed Stokers

The latest refinements in single retort underfeed stokers are discussed in 12-page catalog SB53. Both the fluid ram and gear drive units are described in detail by means of text, elevation drawings, and cut-away views. Erie City Iron Works.

270—Layouts and Specs

Four-page booklet AD-137 covers the LR and the new CB models of self-contained boilers. Suggested boiler room layout and dimensions are included with specifications on both models. Cleaver-Brooks Co.

271—Analyzes Tube Arrangements

More than 30 boiler-setting plans are shown, with an analysis of how each ar-

(Continued on page 78)

NOTE — Each bulletin has a key number for your convenience in asking for a free personal copy. Circle key numbers on reply card facing pages 34 and 74.

Setting machinery?

send for booklet

When grouting power equipment, compressors, pumps, etc., use Embeco Pre-Mixed Grout to assure *lasting* results.

Embeco Pre-Mixed Grout produces a *flowable* grout that is *non-shrink*...insures full bedplate contact... maintains alignment...has high impact-resistance.

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MASTER STANDARD RED LINE & CLEAR Up to 500 lbs.

MASTER CLEAR & RED LINE EXTRA STRONG Up to 600 lbs.

Made in Lengths up to 144" Long And Outside Diameters ⅜", ½", ⅝", ¾", ⅞", 1", 1⅛", 1½".

High Pressure Composition

ERNST RUBBER GASKETS

All sizes to fit your gages and valves

FIG. 21—Lip Mold FIG. 22—Standard

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Whatever your application, you are buying flexible service. For your dollar's sake, it is well to know that *Atlantic* metal hose returns more flexible service than any other hose. Your own performance records will prove it.

For every application, there is an Atlantic flexible metal hose that is JOB TESTED AND CERTIFIED!

Write for Catalog 500 . . . See our catalog in Sweet's File for Product Designers.

Manufacturers of Seamless and Interlocking Flexible Metal Hose in Steel, Stainless Steel, Monel, Bronze . . . Sizes ⅛"-36" I. D. with appropriate fittings.

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REFLEX GAGES
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CLEAR, ACCURATE LIQUID-LEVEL READINGS
in all tanks, boilers, vessels, containers, flow lines.
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- **A** Alloy Steel Bolts for high temperature service
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- **D** Special Composition Gaskets and Cushions are interchangeable
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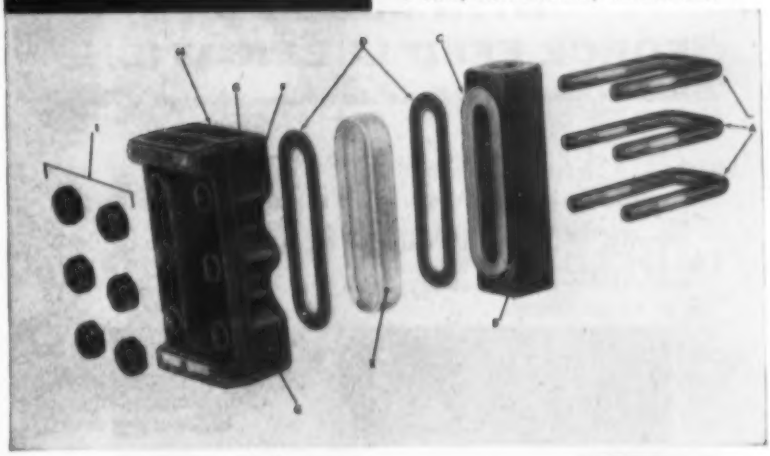

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IS EXCLUSIVE FEATURE

The construction of a Penberthy Gage invites comparison to prove superiority. Note especially the easy glass or gasket replacement and glass cleaning made possible by the fully accessible RAISED FACE. Perfect alignment of frame with glass and gasket is assured. Gasket surface can be repaired without removing assembly from vessel.

Designed for temperatures ranging from sub-zero to over 1000°F. and for test pressures exceeding 15,000 psi., Penberthy gages are used extensively for liquids ranging from water to highly corrosive and dangerous chemicals.

Available in a wide variety of materials including bronze, iron, carbon steel, stainless, monel, etc.

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Manzel Force Feed Lubricators insure efficient machinery operation by lubricating automatically. No stops for hand oiling — or because of breakdowns caused by faulty lubrication. They

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320 BABCOCK STREET, BUFFALO 10, NEW YORK

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bulletins

—Starts on page 76

rangement of tubes is baffled to meet the specific boiler design, in 20-page bulletin BW-54. The Engineer Co.

272—Modern Ways of Burning Coal

"Burning Bituminous Coal the Modern Way" contains 24 pages of case histories from industries of all sizes and types. Engineering survey results for equipment include annual fuel consumption and operating costs. Bituminous Coal Institute.

273—New Tube Cleaner

Bulletin 43 introduces a new geared tube cleaner for removing scale in heat exchanger and condenser tubes of ⅜ to 2½ in. ID. The unit is said to be particularly effective where conditions require low speed and great power. Airetool Mfg. Co.

274—Data on Package Boilers

Two-drum, bent tube package boilers for steam, and high pressure, high temperature hot water are discussed in a four-page folder. Ratings, data, and dimensions are given in table form. Springfield Boiler Co., Div. of John W. Hobbs Corp.

275—Fully Automatic Controls

Specifications for the fully automatic, all electric metering type packaged controls for shop assembled boilers are given in four-page bulletin 54-1088-239. Schematic drawing shows a typical packaged control system. The Hays Corp.

TO REQUEST FREE BULLETINS

Circle "key" numbers on Reply Card facing pages 34 and 74. Your requests will be handled promptly.

276—Explains Curtain Dampers

Booklet 1-HEA on curtain type dampers for flue gas control explains what the damper is and does, construction, dimensions, installations, and gives case histories. Heacon, Inc.

277—Check Your Steam Costs

"Have You Checked Your Steam Costs Lately?" This 15-page handbook is a non-technical presentation of vital interest to everyone considering merits of replacing existing boiler equipment or purchasing new equipment. Orr & Sembower, Inc.

278—Liquid Level Equipment Specs

Liquid level gages, water columns and allied equipment for industrial, chemical, and power plant service are covered in bulletin 11-1-51. Specification and application data are included. Ernst Water Column & Gage Co.

280—New Combustion Sampling

The full story of a newly developed sampling system for continuous trouble-free sampling and oxygen measurement of combustion processes is told in bulletin 703. The equipment described is designed for steam generating plants, rotary kilns and driers, open hearth furnaces, and tanks. Arnold O. Beckman Co., Inc.

287—Shows Products and Facilities

"Products and Facilities," 69-page general catalog G-63-A shows representative

bulletins

—Starts on page 76

examples of products manufactured and some of the numerous facilities for producing them, together with illustrations of installations. Babcock & Wilcox Co.

BUILDING MATERIALS & MAINTENANCE

289—Efficient Floor Maintenance

"Handbook of Building Maintenance" gives valuable information on keeping your plant in efficient working order. Instant-Use concrete floor patch is described along with other materials for repairing floors. Flexrock Co.

290—Repair Leaks with Cement

Text and illustration in this 48-page handbook present repair methods for leaks in pipes, boilers, radiators, concrete, cinderblocks, and sheet and plate metal. Directory describes 12 repair cements and jobs they will do. Smooth-On Mfg. Co.

CORROSION CONTROL

292—Control Corrosion

"Corrosion Control of Electrical Structures and Equipment," 17 pages, is designed to give practical painting information on all phases of transmission and distribution work. Subox, Inc.

COMPRESSORS & BLOWERS

297—Compressors with Dependable Regulation

Bulletin L-675-B1B describes belt-driven and direct-connected motor-driven compressors in detail. These horizontal duplex-type compressors operate at moderate speeds for heavy-duty continuous service. Exclusive Feather Valves are discussed. 36 pages. Worthington Corp.

ELECTRICAL DISTRIBUTION

298—Facts, Figures on Air Breakers

Bulletin 5107-DR-1 contains four pages of facts, figures, features, and photographs on types KA, KB, KC, and LG Urelite air circuit breakers, and on weatherproof and dust-tight enclosures. I-T-E Circuit Breaker Co.

299—Data on Protected Transformers

"Allis-Chalmers Protected Distribution Transformers," eight-page bulletin 61B-7309B, gives operating advantages of the transformers available in rating of 3 through 100 kva, 2400 to 14,400 v, and mechanical data on five type designations. Allis-Chalmers Mfg. Co.

300—Variable Transformer Data

Types 136 and 236 Powerstat Variable Transformers — design, new ratings, and performance—are discussed in eight-page bulletin P354. The Superior Electric Co.

301—Current Limiting Fuses

Hi-Cap fuses for the protection of loads above 600 amp are described in six-page bulletin HCS. Two handy charts are included: Current Limiting Effect and Opening Time Curves. Use of these fuses in conjunction with Fusetron fuses is explained. Bussmann Manufacturing Co.

ELECTRIC UTILIZATION

303—Improved Solid Shaft Motors

Improved types of U. S. vertical solid shaft motors, including Unimount motors in ratings from ¼ to 400 hp in grease and

(Continued on page 80)

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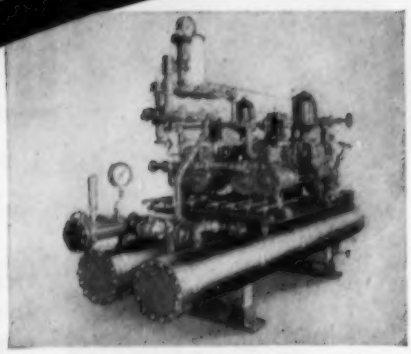
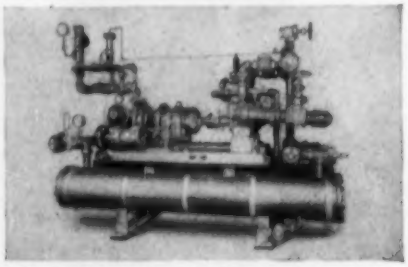


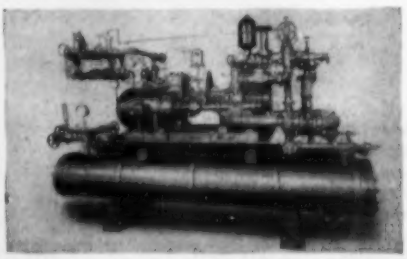
Two Horizontal Duplex Piston Type Steam Pumps and two fuel oil heaters—capacity 15 G. P. M. at 250 lb. pressure with either pump or heater.

Every detail part of an Enco Automatic Oil-Heating-and-Pumping Unit System is designed, assembled, checked and tested to make sure that it functions as an element of a completely coordinated unit. The sizes of pipes, fittings, valves and other elements are correctly proportioned for the efficient, dependable operation of the unit as a whole. All hand controls are visible and within reach of the operator for quick starting, stopping or cross-over reconnections between duplicate heaters and pumps. Adjustments and cleaning are similarly simplified.

Single or duplicate heaters and electric or steam-driven pumps are used. Interconnected duplicate units give full capacity with either pump or either heater. Capacities range from 100 to 5000 G. P. H. of heavy bunker oil.



One Turbine and One Motor Driven Pump and two fuel oil heaters. Capacity 30 G. P. M. at 150 lb. pressure with either pump or heater.



One Horizontal Duplex Piston Type Steam Pump and one Motor Driven Pump and two fuel oil heaters. Capacity 20 G. P. M. at 300 lb. pressure with either pump or heater.

BULLETINS ON REQUEST

OB-37 On oil burning, pumping and heating equipment.

OB-38 Instruction book on care and operation of oil-burner installations.

THE ENGINEER COMPANY
75 WEST STREET Enco NEW YORK 6, N. Y.

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bulletins

—Starts on page 78

oil lubricated types and U. S. footless type horizontal motors for direct connection, are illustrated and described in bulletin 1868. U. S. Electrical Motors, Inc.

HEAT EXCHANGERS & WATER HEATERS

305—Heat Exchange Equipment Specs

This 16-page bulletin gives all pertinent specification data for hot water storage heaters, instantaneous and converter heat exchangers, instantaneous and converter water heaters, and fuel oil heaters. Patterson-Kelley Co., Inc.

INSTRUMENTS & CONTROLS

306—Investigate Controls

The Gotham line of indicating, recording, and controlling instruments is summarized in four-page bulletin GL-1. Included are photos and descriptions. United States Gauge Div., American Machine and Metals, Inc.

307—Control Valve Reference Book

Three basic types of single seated diaphragm control valves are discussed in 15-page bulletin 5304. Cut-away views and charts with complete specification data make this a good reference book. Leslie Co.

308—Control Those Temperatures

Temperature control by means of temperature regulators that combine both a pressure and thermal element is discussed in four-page folder 1008. Spence Engineering Co., Inc.

310—Automation Dictionary

This "Automation Dictionary" covers some 87 words and phrases in the expanding vocabulary of automation. These are not standard engineering definitions but new engineering terms defined for the average engineer. Minneapolis-Honeywell Regulator Co., Industrial Div.

TO REQUEST FREE BULLETINS
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312—Measure Feedwater Gas

Described in four-page folder 148BP is an analyzer for measuring dissolved oxygen and hydrogen in feedwater. Advantages, ranges and accuracy are discussed. Cambridge Instrument Co., Inc.

LUBRICATION

314—Stop Oil Contamination

Eight-page bulletin F-132 describes in detail construction and operation of hydraulic systems with special emphasis on contamination of hydraulic fluids from various causes, and demonstrates the correct filtration system. The Hilliard Corp.

315—The Story of Bearing Lubrication

"Industrial Bearing Lubrication" is a reprint from the magazine **Lubrication**, October, 1954, issue. The article covers bearing design, surface, overhaul, and aspects of lubrication. The Texas Co.

316—Proper Motor Lubrication

"Lubrication of Electric Motors: Ball and Roller Bearing Type," four-page bulletin 504, fully describes proper methods

bulletins

—Starts on page 78

for lubricating and cleaning ball and roller bearings on electric motors. New York & New Jersey Lubricant Co.

POWER TRANSMISSION — MECHANICAL

317—Centrifugal Clutch Coupling

Eight-page bulletin CE-3 explains the 11 new important features of the Twiflex flexible automatic centrifugal clutch coupling. This is not just a catalog, but a collection of valuable engineering data on this type of coupling. The Hilliard Corp.

319—Adjustable Speed Principles

Principle of operation and use of Dynamatic Eddy-Current adjustable speed equipment is described in 16-page bulletin GB-2. Typical torque and load curves are given. Dynamic Div., Eaton Mfg. Corp.

320—Eddy-Current Brakes

Standard eddy-current brakes and associated controls in both air and liquid cooled types are described in 11-page bulletin BR-1. Construction details, capacities, characteristic curves, and dimensions are listed. Dynamatic Div., Eaton Mfg. Co.

321—Parallel Shaft Gears

"Parallel Shaft Gear Drives," 32-page booklet 2619, contains engineering data including simplified horsepower tables, dimensions, and overhung load capacities for selections from the standard line. Link-Belt Co.

322—Diesel Engine Ratings

DR Diesel Engines, as used in municipal power plants, water works, sewage treatment plants, and other industrial applications, are shown in eight-page bulletin S-500-B52B. Rating chart gives information on 5, 6, 7, and 8 cylinder engines from 550 to 2200 hp. Worthington Corp.

PIPING, VALVES, & SPECIALTIES

323—Pressure Valves For All Ranges

Catalog 10 describes List 960 and 990 valves. The 960 is for a pressure range of 200 lb at 100 F to 380 lb at 1000 F. The 990 is for higher pressures. Chapman Valve Manufacturing Co.

Torque Wrenches In Wide Range

Both inch-pound and foot-pound torquers are described in this complete 68-page catalog. Types included are for a wide range of drive sizes with plain or ratchet head. **Please send requests directly to Proto Tool Co., Dept. IP, 2762 Santa Fe Ave., Los Angeles 54, Calif., with 10c.**

324—Avoid Clogging Steam Equipment

You can prevent rust, scale, and dirt from clogging steam equipment with use of Yarway fine-screen strainers, according to six-page bulletin S-204. Tables give prices, rates, dimensions, and woven screen data. Yarnall-Waring Co.

325—Why Not a Solenoid Valve?

If you use direct operated solenoid valves for automatic or remote flow control of liquids and steam up to 400 F, or of high viscosity liquids you will want to read 11-page bulletin V-2. Normally closed, normally open, explosion-proof normally closed, and three way valves are shown. The Johnson Corp.

326—Selecting Ball Float Traps

Ball float traps for draining water from air, gas, or steam lines or for draining light liquids from gas under pressure are described in eight-page bulletin 289. An orifice capacity chart and tables of maximum operating pressures help in selection. Armstrong Machine Works.

327—Valves For Every Use

Needle, globe, plug, check, relief, and special valves are described in 44-page catalog 352A. Units listed are made of various metals, and are suitable for instrumentation, processing industries, hydraulic systems. Republic Manufacturing Co.

328—Valve and Regulator Data

Specifications and operational data for steam, gas, air, oil, and water regulating equipment are presented in 60-page catalog 54. Illustrations and descriptions are included for pressure, temperature, and combination regulators, diaphragm, float, motor, solenoid, pop, and relief valves. O. C. Keckley Co.

329—Pneumatic Relays and Pilot Valves

Two-page leaflet 359 describes pneumatic relays and pilot valves, pressure-electric switches, and electric pneumatic valves. Included are gradual direct acting relays, gradual reverse acting relays, and gradual retarded, advanced, and minimum pressure relays. The Powers Regulator Co.

332—Advantages of Multiport Valves

Three types of Multiport Relief Valves are described in 20-page catalog 5200. The booklet explains how these valves can provide maximum safety, overpressure regulation, ease of adjustment, and substantial savings. Cochrane Corp.

(Continued on page 82)

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BEST FOR MOTORS!

NON-FLUID OIL does not leak, creep or throw out, but *stays in* motor bearings to lubricate dependably until entirely consumed. Ordinary oil escapes from bearings and soaks motor windings — resulting in short-circuits and costly "burn-outs".

NON-FLUID OIL keeps electric motors running longer, cooler, cleaner. Buy NON-FLUID OIL and be sure; it does away with dangerous oil-soaked windings caused by so-called cheap oils, and is ideal for ring oiling motors. Other grades specially suited to ball and roller bearing type motors — offer equal advantages.

For proof of performance write for Bulletin No. 504 and free sample of NON-FLUID OIL.

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WAREHOUSES: Birmingham, Ala. • Atlanta, Ga. • Columbus, Ga. Charlotte, N. C. • Greensboro, N. C. • Greenville, S. C. • Chicago, Ill. Springfield, Mass. • Detroit, Mich. • St. Louis, Mo. • Providence, R. I. Also represented in other principal cities.

NON-FLUID OIL is not the name of a general class of lubricants, but is a specific product of our manufacture.

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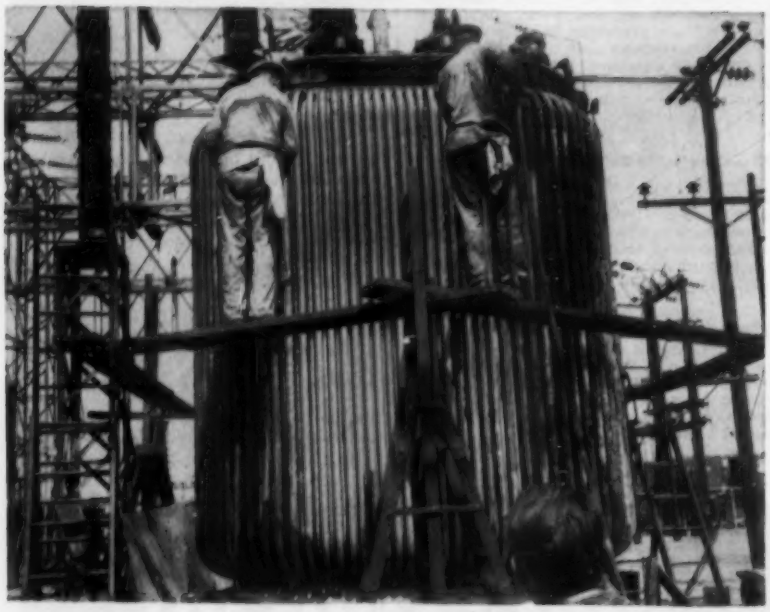

• Subox paints assure both good radiation and excellent protection for transformers and sub-station equipment. They are easily applied by brush, spray or flow-coating. Use them on your present equipment—specify them on your present equipment—specify them on your new.

• All varieties of Subox and Subalox can now be supplied with a faster-drying vehicle for distribution transformers and other shop work.

• Sub-station structures can often be painted with a single coat and a minimum of outages.

• Industrial-type fences can be amply protected with one coat applied by floor brooms.

Write For A Free Copy of "Corrosion Control of Electrical Structures and Equipment"

Subox Inc.

9 Fairmount Plant, Hackensack, N. J.

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bulletins

—Starts on page 76

335—Proven Flexible Metal Hose

For what purpose do you use flexible metal hose? Whatever your application, you will find valuable information about job tested and certified hose in catalog 500. Included are data on steel, stainless steel, monel, and bronze hose in sizes 1/3 to 36 in. ID. Atlantic Metal Hose Co.

336—Data on Pipe Fabrication

Specifications for all sizes of pipe from ⅛ to 24 in. in diameter are presented in 16-page catalog 575C. Tables give data and descriptions of standard, extra strong, and double extra heavy pipe, spiralweld pipe, large OD pipe, line pipe, electric-weld tubing, welding fittings and flanges, oil well casing, and water well casing. Facilities for fabricating pipe for structural uses also are discussed. L. B. Foster Co.

PUMPS

337—Reduced Speeds Possible

Darcova Pumcups, which permit equipment to be operated at reduced speeds, are described in two bulletins: No. 4502 on Pumcups for air or hydraulic mechanisms; and 4401 on units for reciprocating pumps. Darling Valve & Mfg. Co.

338—Centrifugal Pump Specs

Centrifugal Pumps — Four-page bulletin 512-A gives complete information on the Type SB horizontally split case, double balanced suction pumps including dimensional drawings. Weinman Pump Mfg. Co.

339—Need a Sump Pump?

Automatic sump pumps, standard series, explosion-proof, totally enclosed, and submersible type are described in four-page folder 5382. Penberthy Injector Co., Div. of Buffalo-Eclipse Corp.

341—Range of Proportioning Pumps

Controlled capacity pumps and proportioning equipment for capacities from a few cc per hour to over 3300 gal per hr are covered in catalog S-1254. Types of pumps described include both simplex and duplex standard (up to 1500 psi) and low pressure (up to 800 psi). Philadelphia Pump & Machinery Co.

342—Construction of Suction Pumps

"KS Double-Suction Pumps," 4-page folder 06B8233, describes construction features of these new pumps for air conditioning and general purpose applications. Included are dimension and sizing charts. Allis-Chalmers Mfg. Co.

343—Quick Reference to Vacuum Pumps

Four-page bulletin V-54 provides a quick but comprehensive view of the complete line of high vacuum pumps ranging in size from a ¼ hp unit with a displacement of 2 cfm to a 40 hp unit with a displacement of 780 cfm. Construction and operating characteristics of single stage, compound, and two-stage mechanical booster types are discussed. Kinney Mfg. Div., New York Air Brake Co.

REFRACTORIES & INSULATION

344—Castable Refractory Services

Bulletin 35 describes the service whereby this company provides engineering materials and erection service for vessel lining or heat enclosure jobs. Bigelow-Liptak Corp.

bulletins

—Starts on page 79

345—How to Select Refractory

"Boiler Refractories," 20-page bulletin R-36, has been designed to provide operators of stationary and marine boilers with an authoritative guide for selecting the most efficient and economical refractories for their boilers. Babcock & Wilcox Co., Refractories Div.

346—Using Sheet Insulation

"Marinite For Driers, Ovens, Breechings, and Housings," 16-page booklet IN-153 A, tells you how you can build and insulate with this sheet material. Handling and working recommendations, data on physical and thermal properties, and construction and fabrication suggestions are given. Johns-Manville.

347—Steam Turbine Details

Rugged, easily maintained steam turbines with shaft-type mechanical governors are discussed in detail in Catalog 500. Also listed are optional accessories. 16 pages. Dean Hill Pump Co.

TURBINES & STEAM ENGINES

348—Low-Cost Power

If you use steam for heating, cooking, or processing, you can get power at almost no cost with the use of a Wing steam turbine, according to bulletin SW-1a. Construction of these units gives an almost infinite range of speeds, easy control by throttling. L. J. Wing Mfg. Co.

349—Design of Multi-Stage Turbines

Smaller framed, multi-stage turbines are featured in six-page bulletin. Overspeed governor, governor valves, blades, diaphragms, and many other design features are discussed. Terry Steam Turbine Co.

TO REQUEST FREE BULLETINS

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350—Select an Economical Turbine

Full details of this company's steam turbine are given in bulletin 135. How to save operating and maintenance costs by buying the right size for individual needs is explained. Coppus Engineering Corp.

351—Flexible Designed Turbines

Fully-illustrated 24-page bulletin 1961 emphasizes the flexibility of design of the Type-S turbine which is said to make possible selection of the proper number of stages, governor, and controls to give maximum efficiency. Worthington Corp.

WASTE DISPOSAL

352—Waste Problems solved

How this company has solved waste treatment problems for such industries as electro-plating, refinery, gas, and metal finishing is treated in detail in six-page booklet 70-B. Infilco, Inc.

WATER TREATMENT

353—Protection Helps Heat Transfer

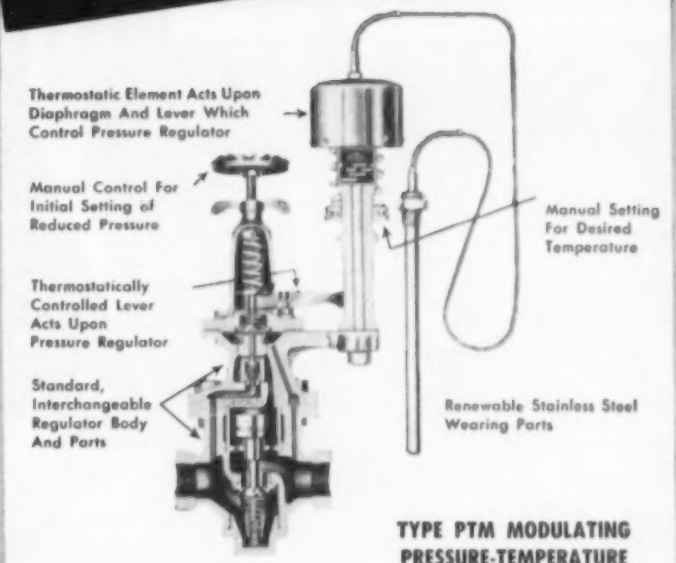
"Film Forming Corrosion Inhibitors Also Aid Heat Transfer," four-page technical paper No. 129, contains references to protection afforded by filming amines and attendant reduction in maintenance costs secured through protection against corrosion. W. H. & L. D. Betz.

(Continued on page 84)

THIS NEW KECKLEY REGULATING VALVE GIVES

Finer Temperature Control

THAN EVER BEFORE POSSIBLE!


Thermostatic Element Acts Upon Diaphragm And Lever Which Control Pressure Regulator
Manual Control For Initial Setting of Reduced Pressure
Thermostatically Controlled Lever Acts Upon Pressure Regulator
Standard, Interchangeable Regulator Body And Parts
Manual Setting For Desired Temperature
Renewable Stainless Steel Wearing Parts

TYPE PTM MODULATING PRESSURE-TEMPERATURE REGULATOR

Costs No More Than Less Sensitive Separate Units

The new Keckley Type PTM modulating pressure-temperature regulator establishes a new standard of accuracy of temperature regulation for batch processing, air ducts and other exacting control jobs. As temperature tends to vary, the thermostatic control unit acts upon the pressure regulator to reduce or increase steam pressure. Pressure will modulate smoothly and rapidly between the initial setting and zero, thereby preventing overrun. Rate of pressure modulation is adjustable, giving the user a wide choice of control.

This new valve costs no more than separate Pressure and Temperature Regulators but gives much finer control and a simpler installation. Originally developed to meet exacting TVA specifications, Type PTM is a refinement upon earlier Keckley types, which are still catalogued for average requirements.

Ask for your copy of the new Catalog 54-E describing the complete Keckley line of Steam and Liquid Control Equipment.

O. C. KECKLEY COMPANY

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Pressure Regulators • Temperature Regulators • Float Valves
Diaphragm Valves • Safety and Relief Valves • Solenoid Valves

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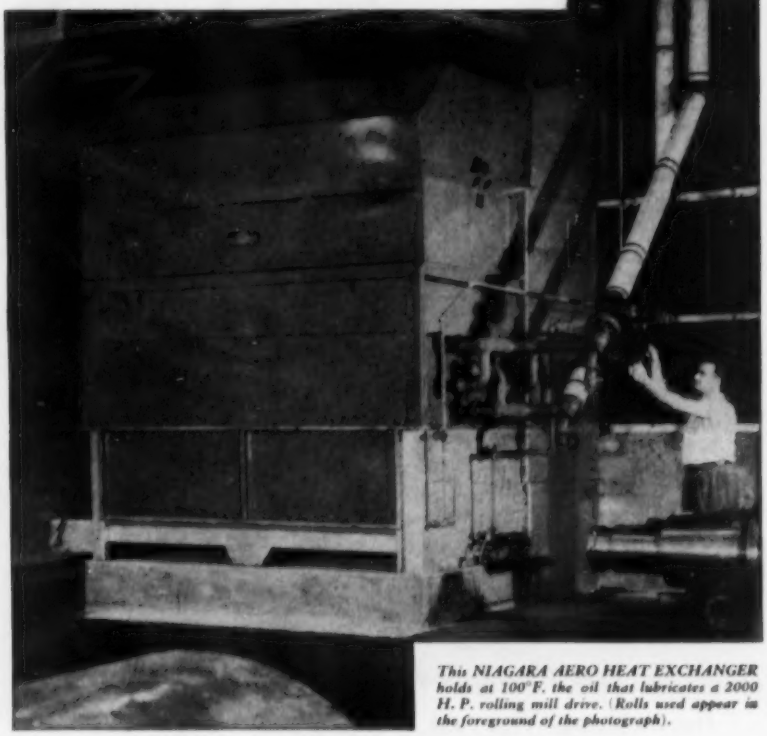
ACCURATE CONTROL OF LIQUID TEMPERATURES



This NIAGARA AERO HEAT EXCHANGER holds at 100°F. the oil that lubricates a 2000 H. P. rolling mill drive. (Rolls used appear in the foreground of the photograph).

The Niagara Aero Heat Exchanger uses atmospheric air to cool liquids and gases by evaporative cooling, removing the heat at the rate of input, controlling temperatures precisely. You save 95% of the cost of cooling water. You get great saving in piping, pumping and power, quickly getting back the cost of the installation.

You can cool and hold accurately the temperature of all fluids, air and gases, water, oils, solutions, chemicals for processes and coolants for mechanical and electrical equipment. You can cool welding machines, hydraulic and extrusion presses, plastic molds, furnaces, controlled atmospheres, quench baths, obtaining better results with precise temperature. You obtain closed system cooling, free from dirt or scale.

For further information, write for Bulletin No. 120 I.P.

NIAGARA BLOWER COMPANY

Dept. I.P., 405 Lexington Ave. New York 17, N. Y.

Niagara District Engineers in Principal Cities of United States and Canada

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bulletins

—Starts on page 76

354—All Phases of Purification
"Boiler Feedwater Treatment," 19-page bulletin BFT-1, covers Inversand zeolite softeners, color process chemical softeners, and demineralizing units, including silica removal by ion-exchange. Hungerford & Terry, Inc.

355—Complete Ion Exchanger Data
Strongly basic anion exchanger is presented in bulletin 57 which includes complete data on physical characteristics, exchange capacity and regeneration technique. National Aluminate Corp.

356—Stop Boiler Water Foam
Laboratory pictures in this four-page folder show how Concentrol controls boiler water foam. Examples of its use in various industries are given along with an explanation of foaming. Bird-Archer Co.

357—Demineralizing Handbook
"Handbook on Demineralizing," 40-page bulletin 5900-B, compares various methods of water treatment including demineralizers and evaporators. It goes into characteristics of various types of available cation and anion exchange materials and operating costs. Cochrane Corp.

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358—Supplementary Water Treatment
"No. 40 Series Supplementary Treatments," three-page booklet 28X8226, discusses supplementary treatments for boiler makeup water such as treatments for softening traces of hardness, dispersives for conditioning of sludge, oxygen scavengers, and anti-foam agents. Allis-Chalmers Manufacturing Co.

359—Spray-atomizing Deaerators
Spray-atomizing type units are shown in cross-section in four-page booklet 400. Function, design and operation, construction, outstanding features, and uses are discussed. American Water Softener Co.

360—How to Use Package Feeders
Proportioning pumps and package chemical feeding units are described in this four-page folder. With liquid ends available for about 85 percent of all chemical pumping requirements, the pump is designed for use where a controlled capacity of fluid is necessary. How the feeding unit can be connected to the piping of your plant and to the electrical control equipment is explained. Bird-Archer Co.

361—Trouble-Free Chemical Feeders
Install Series 50-T chemical feeder on your boiler feed-water pumps and you can forget troubles due to guesswork, inaccuracy, or forgetfulness according to four-page folder 5M. Flow diagrams explain operation and advantages. Manzel Div. of Frontier Industries.

362—How to Supply Your Own Water
Methods of abstracting water from the ground or by infiltration through permeable beds of rivers or other bodies of water are discussed in 20-page bulletin. Performance charts for this company's collector are supplemented with cross-sectional drawings and cut aways. Ranney Method Water Supplies, Inc.

car and two truck unloading stations. Both tank trucks and their trailers can be unloaded simultaneously, reducing the total unloading time. The unloading lines are equipped with sight flow check valves so that visual proof is available that the transportation vehicles are empty.

The LP gas is converted to vapor in a steam heated vaporizer, capable of vaporizing 3000 gallons of propane per hour. The propane-air mixture is controlled by a flow ratio system designed to deliver 200,000 cubic feet of propane-air mixture per hour at a pressure of 15 pounds. The propane-air mixture is continually sampled for its heating value.

New Life For Old Boiler

By combining a vertical pump for boiler feed with a magnetic float switch on the boiler water column, the Fairmont Foods Company, Lawton, Oklahoma was able to put an old HRT boiler on an automatic basis. The boiler is operated unattended since the pump and controls were installed.

The boiler supplies constant steam for process heating. A Deming four-stage centrifugal high-pressure pump was installed to feed cold water from an open tank into the boiler. The pump delivers at 100 psi, and handles water up to 250 F. A magnetic float switch on the boiler water column controls the pump operation as the water level changes in the boiler. The same switch shuts off the burner when the water level drops too low.

Radioactive Fire Detectors

A revolutionary means of detecting fire in the earliest stages, without dependence on visible smoke or heat for actuation, was demonstrated by Pyrene—C-O-Two. The heart of the system is a pre-detector head containing a radioactive element. The head contains a highly sensitive gas discharge tube plus two independent chambers. One chamber is exposed to the atmosphere and the other is sealed from the atmosphere. A minute amount of radioactive material is put in each chamber. The radiation ionizes the air, causing the air in each chamber to become electrically conductive.

The chambers are adjusted to give equal voltage when combustion gases or smoke do not exist. When combustion gases or smoke make their appearance, the balance condition ceases and the gas discharge tube becomes conductive. This in turn operates a relay and the alarm is on its way.

The pre-detector heads, spaced on 60-foot centers and 30 feet from side walls, can detect the smallest smoldering fire and indicate its location. Among other installations, the radioactive fire detectors have been installed in an electric power plant. Underwriters' Laboratories' approval has been secured.

Gas Turbine for Mexican Industry

General Electric will manufacture two 16,000-kw combustion gas-turbine-generator sets for a Mexican industrial firm—Planta Electrica of Groupo Industrial—

(Continued on page 86)

For combustion testing in the field!

HAYS ORSAT TYPE GAS ANALYZER

The first of its type developed for field work, the Hays Analyzer answers the need for an Orsat type gas analyzer husky enough for use in the boiler room and for installation and service work in commercial and home heating plants, yet simple, fast and accurate!

It's Rugged—Made with strong pressed steel, the Hays Orsat is designed for continuous boiler room operation and field work . . . takes wear and tear in stride!

It's Portable—The Hays Orsat contains everything needed for *complete* analysis (CO_2, O_2, CO) in one light (only 8 lbs.), easy-to-carry case . . . goes wherever it's needed. Compact, with all parts easily accessible.

Available in one, two or three unit styles. Does a complete testing job for CO_2, O_2 and CO in 3 minutes!

Send for publication 54-668-27—a complete description of all styles.

Automatic Combustion Control
Boiler Panels • CO_2 Recorders
Variflow Meters and Varitrol
Gas Analyzers • Draft Gages
Combustion Test Sets
Electronic Oxygen Recorders
Electronic Flowmeters
Electronic Feed Water Controls
Miniature Remote Indicators

THE hays CORPORATION

MICHIGAN CITY 2, INDIANA

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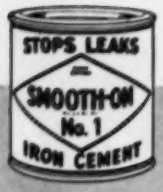

How to use SMOOTH-ON Iron Repair Cement

Once you see *how* Smooth-On works you get an idea of the many repairs it can make! Smooth-On No. 1 is a powder you mix with water to a putty-like consistency. You force it into cracks or other openings. All Smooth-On ever asks is something firm to expand against. Once in place it holds tight against steam, water, fire, air or gas, and holds under pressure or vacuum. It will not soften or deteriorate through age—at least it hasn't *yet!* We have samples on display which were made up in 1895. They are as sound as ever.
Keep Smooth-On No. 1, quick-setting, or No. 2, slower setting, handy.

TYPICAL USES:

- Making tight joints and seams
- Filling voids in machinery or pipe lines
- Assembling parts
- Tightening loose screws, bolts, parts, handles, etc.
- Repairing worn or corroded metal areas
- Stopping leaks in boilers, pipe lines, pressure containers, etc.
- Making all kinds of emergency repairs

FREE REPAIR HANDBOOK

A new, revised 48-page edition, explains in detail how to make dozens of typical repairs which save both time and money in factory, garage, power plant, and home. Ask your supply house for a copy or write us. SOON

SMOOTH-ON MANUFACTURING COMPANY
Dept. 19, 570 Communipaw Avenue, Jersey City 4, N. J.

SMOOTH-ON

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ideas in action

—Starts on page 100

in Monterrey, Mexico. These two simple-cycle, single-shaft sets will be the largest yet manufactured in the Western hemisphere. Natural gas will be the fuel. Eventually, the heat and the exhaust gas of the turbines will be used to generate process steam in heat recovery boilers. Several smaller installations in the United States, using gas turbines for mechanical drive or power generation, now utilize turbine exhaust heat in heat recovery boilers to make process steam.

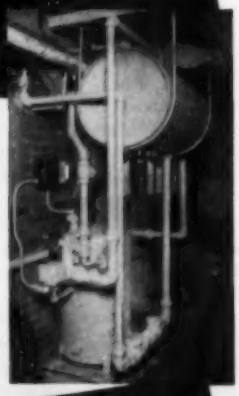
New Way To Beat Rust

Arthur D. Little, Inc. reports on the latest approach to rust prevention—the vapor-phase inhibitors. These are organic chemicals that evaporate slowly, depositing the active rust-inhibiting agent on the surfaces to be protected. The use of the vapor phase gives rise to the most attractive property of such inhibitors, namely, their ability to reach all exposed surfaces by diffusion through the surrounding atmosphere rather than by mechanical application.

Only thin films of these volatile rust inhibitors are required. The inhibitors work by forming a thin chemical film on the surface being protected, thus regulating the surface's electric potential. This prevents movement of rust-forming ions to the metal surfaces. Some

(Continued on page 87)

END FLASH LOSS and COOLING LOSSES...



. . . in handling condensate from high pressure processing equipment

Here's the system, engineered around the Johnson Electrap, that gets high temperature condensate back to boiler room with all heat units still intact. In contrast with the usual pump and receiver installation, it eliminates the losses that come with unrestricted flashing of condensate and the addition of cooling water. In many cases this can mean direct savings of 10% and more in fuel and power.

New Data Book has complete engineering information; write for copy today.

The Johnson ELECTRAP for Pumping Service

The Johnson Corporation

807 Wood St., Three Rivers, Mich.

Circle 550 on Reply Card for more data

of the inhibitors are actually water repellent.

The inhibitor vapor must be maintained above a minimum concentration so that the film does not evaporate from the protected surfaces (in much the same manner as it was deposited there). Thus, these inhibitors find their primary application in protecting surfaces in confined spaces where inhibitor vapor pressures can be built up. These inhibitors are not suitable for some applications involving non-ferrous metals because they may create more corrosion than they were intended to prevent. It is possible, however, that inhibitors will be designed in the future that will be useful with non-ferrous metals and that will employ the same vapor-phase technique of application.

Good Idea is 26 Years Old

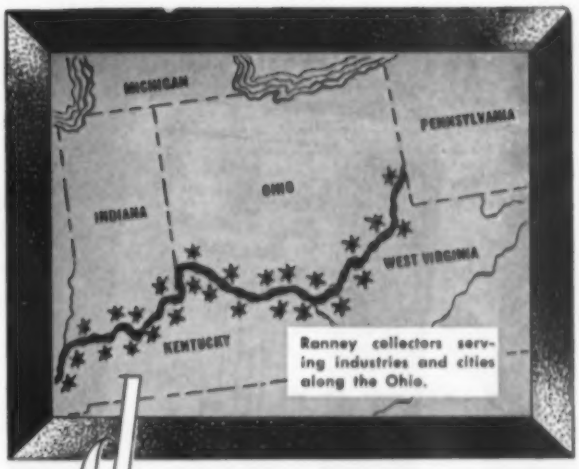
Three 48-inch Byron Jackson vertical propeller pumps were installed 26 years ago in California Reclamation District No. 1500. They have operated for some 70,000 pumping hours each, and together have pumped a total of 567 billion gallons of water during the 26 years.

This particular pump application, representing an idea in action for some 26 years, was just opened and inspected. It was found that only minor repairs were required before the pumps could be put back to work for another 26 years or more.

meetings

. . . for industry & power

May 16-20	National Materials Handling Exposition	Int'l. Amphitheater Chicago, Ill.
May 22-26	Air Pollution Control Assoc. (48th An. Meeting)	Detroit, Mich.
June 6-9	American Society of Mechanical Engineers (Oil & Gas Power Conf.)	Hotel Statler Washington, D.C.
June 7-10	American Welding Society (Spring Meeting and Show)	Hotel Muehleback Kansas City, Mo.
June 12-17	American Waterworks Association (Annual Conference)	Chicago, Ill.
June 19-23	American Society of Mechanical Engineers (Semi-Annual Meeting)	Hotel Statler Boston, Mass.
June 27-July 1	American Institute of Electrical Engineers (Summer General Meeting)	New Ocean House Swampscott, Mass.
July 12-14	Western Plant Maintenance and Engineering Show	Pan Pacific Auditorium Los Angeles, Calif.
Aug. 15-19	American Institute of Electrical Engineers (Pacific General Meeting)	Butte, Montana
Sept. 26-30	Atomic Industrial Trade Fair	Sheraton-Park Hotel Washington, D. C.



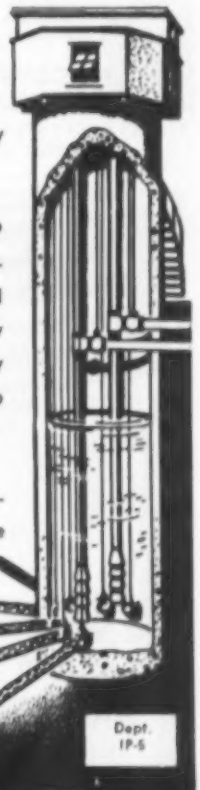
Dipping our fingers in the Ohio!

208.8 MILLION GALLONS PER DAY

Here is more proof that the RANNEY METHOD is the most effective, economical means of collecting huge volumes of naturally filtered, non-turbid water.

43 collectors, representing 9 chemical plants, 2 distilleries, 2 Ordnance Plants, 1 Steel Company, and 3 Municipal Water Supplies, are now producing an abundant water supply by infiltration. Results here, as in so many areas, are highly satisfactory.

Take advantage of this low-cost insurance against water shortage problems, without the expense of filter plants and treatment stations.



Dept. IP-5

RANNEY METHOD

Water Supplies Inc.

Water Supply Engineers and Contractors

841 Alton Columbus 19, Ohio

Associate: Ranney Method Western Corporation

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Continuous records of the oxygen dissolved in boiling feed water and of the hydrogen entrained in steam, point to the corrective measures necessary to prevent otherwise unsuspected and costly corrosion. The Cambridge Analyzers measure and record dissolved oxygen directly. The hydrogen in the steam is measure of the oxygen set free by dissociation. Cambridge Instruments are available for recording O_2 and H_2 either separately or simultaneously.

Send for Bulletin 148-BP

CAMBRIDGE INSTRUMENT CO., INC.

3060 Grand Central Terminal, New York 17

PIONEER MANUFACTURERS OF PRECISION INSTRUMENTS

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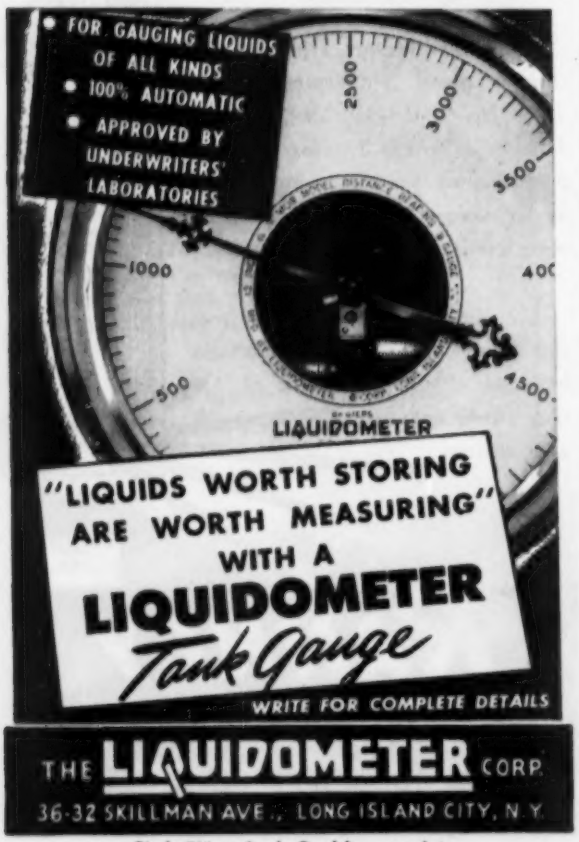


THE LIQUIDOMETER CORP.

36-32 SKILLMAN AVE., LONG ISLAND CITY, N. Y.

Circle 553 on Reply Card for more data

spot news

. . . . about industry & power

• Reversing Motor Trends

The trend toward more-complete motor enclosures may soon reverse because an insulation has been announced that is unaffected by any of the contaminants that previously would have commanded use of totally enclosed frames. Allis-Chalmers and Dow-Corning have jointly announced the first all-silicone-rubber insulating system for large motors and generators. Because the insulation is little affected by abrasive dusts, new application practices are expected for these motors in induced draft fans and in steel-mill drives. Semi-protected or open motors with this insulation can be used where TEFC's formerly would have been required in chemical, paper, food, and similar plants.

This insulation is called the *Silco-Flex* insulation system by Allis-Chalmers and uses Dow-Corning's *Silastic* silicone rubber. Allis-Chalmers intends using it first on motors of about 1000 hp at 2300 and 4000 volts. These motors should become available in standard ratings at normal list prices in the next several months.

• Hemispheric Unity

Great strides are reported in developing unity among engineers of the Western Hemisphere. The Engineers Joint Council represents the United States engineering profession in UPADI (Panamerican Federation of Engineering Societies). The secretary of EJC's Committee on International Relations, Brig. General Stewart E. Reimel, says that the UPADI program is of importance, among other things, because of its "promotion of engineering and industrial standards in an effort to eliminate confusion in this field." General Reimel also sees UPADI as being a "potent weapon in combating the insidious infiltration of totalitarian ideologies." UPADI has set July 20 as Pan-american Engineer's Day.

• Hope for Standard Threads

On another international front, hope was expressed for continued progress in standardization of screw threads and gauging by the English-speaking countries. This hope was voiced by Roger Gay, president of Bristol Brass, and past president of the American Standards Association. He spoke to the delegates attending the ASME's American-British-Canadian Conference on Engineering Standards.

• Sees Television for Industry

Expanded use of television in industry was seen by Robert H. Johnston, General Precision Laboratories. He estimates that there are some 1500 industrial television installations today. He cites four categories of service where industry can use television best:

¶ Where action occurs too far away to be seen clearly, such as transmitting blueprint information from a central drafting room.

¶ Where danger exists, such as radioactive areas.

¶ Where an action is confined to an area too small for the desired audience, such as showing medical operations at close range to many viewers.

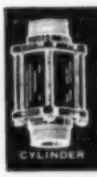
¶ Where a circuit could relieve personnel for more productive jobs, such as central monitoring of remote sub-stations.

CLASSIFIED ADVERTISING

PROFESSIONAL SERVICES

complete Anhydrous Ammonia and L.P. Gas plants
designed - installed
H. Emerson Thomas & Associates, Inc.
P. O. BOX 370 · WESTFIELD, N. J. · WE 2-2800

FOR SALE



FLOW INDICATORS
All sizes up to 6"
SEND FOR CATALOG
ERNST
Water Column & Gage Co.
LIVINGSTON, N. J.

PROFESSIONAL SERVICES

PROPANE GAS PLANTS
and
Anhydrous Ammonia Plants
PEACOCK CORPORATION
Box 268, Westfield, N. J. Westfield 2-6258

AVAILABLE REPRINTS

SPECIAL REPORT REPRINTS

One free copy of each of the listed Special Report Reprints mailed upon request. Additional copies: 2 to 25 copies — 25¢ each; 26 to 50 copies — 20¢ each; 51 to 100 copies — 15¢ each; more than 100 copies — 10¢ each. Address requests, preferably on company letterhead, to: **Reader Service Department, INDUSTRY & POWER, Commercial Bank Building, St. Joseph, Michigan.**

"Annual Review and Forecast, 1955"
"In-Plant Electrical Distribution"
"The Packaged Boiler Picture"
"Control Valves and Positioners"
"Adjustable Speed Drives and Electrical Controls"
"Combating Corrosion From Industrial Chemicals"
"Demineralization—A Means to Purer Water"
"Contaminants In the Air"
"Fundamentals of Automatic Control"
"Industrial Waste Treatment"

FREE REPRINTS

The reprints listed below are available for your personal reference files, free of charge. Write on your company letterhead to: Reader Service Department, INDUSTRY & POWER, St. Joseph, Michigan.

"A Better Water At Lower Cost"
"Big Savings For A Small Plant"
"Burners For Package Boilers"
"Bring Back Those Blowdown Btu's"
"Coal Burning Equipment Application and Selection"
"Combustion And Combustion Guides"
"Demineralization . . . A Means of Purer Water"
"Electrically Heated Pipelines Keep Fuel Oil Flowing"
"Engineered Incineration"
"Engineered Insulation"
"Fundamental Designs and Design Considerations of Industrial Condensers"
"How To Select Corrugated Expansion Joints"
"Instruments To Fit The Job"
"Joining Copper and Its Alloys"
"Modern System Moves 600 Ton of Coal Per Hour"
"Profits From Wastes"
"Purchased Vs Generated Power"
"Reducing Boiler Plant Operating Costs"
"Specifying Paint Protection"
"Selecting Taps On Power Transformers"
"Synchronous Motors Do Two Jobs At One Time"
"Short Short-Circuit Calculations"
"Small Filters Do Big Job"
"Shell Selects Package Boiler for Outdoor Operation"
"Selection and Design Factors in Bus Duct Distribution Systems"
"The Warm And Cold Tank System For Multiple Station Cooling"
"Television . . . The Eyes Of Industrial Control"
"We Planned Our Power Plant's Growth"
"When to Use Eddy Current Couplings for Speed Control and Clutching"
"Why High Temperature Water"
"Coal Dust . . . Stopped Before It Starts"
"LP Means Loss Protection"
"The Economic Limits for Power Factor Corrections"
"Reclaim Your Waste Heat"
"Bulk Handling as a Business"
"Which Should It Be . . . Electric or Pneumatic Controls?"

ENGINEERS WANTED

Power Engineer, with proven ability to direct the efficient and economical operation and maintenance of steam and electrical generating equipment. Opening is with a medium size paperboard mill supervising upwards of 20 men. Give complete resume' of education and experience stating age and salary expected. All replies confidential.
Box E1, Industry and Power, St. Joseph, Mich.

COAL ASSOCIATION EXECUTIVE SALES ENGINEERING SERVICE
The National Coal Association is seeking an executive, a qualified engineer, to direct administrative and promotional activities in field sales engineering service in furthering the use of coal to industry. Must have experience related to the usage of coal, preferably in industry, an understanding and appreciation of the economics of coal, and possess a strong personal makeup. Ability to deal with people, develop selling programs, and plan and direct organizational efforts. Engineering degree preferred. Age 30-50. Growth opportunity. Compensation appropriate for a qualified man. Please send reply in detail in confidence to Market Promotion Committee, Box E2.

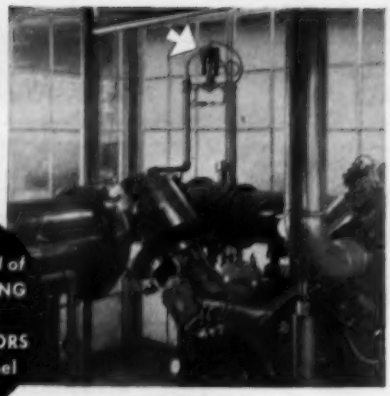
next month in INDUSTRY & POWER

the story of the Power Services behind the Salk Polio Vaccine

INDUSTRY & POWER will take you to the plant of Eli Lilly And Company, the nation's major producer of the Salk Polio Vaccine. You will meet the engineers and the equipment that put the power behind Salk Polio Vaccine production. And you will see how Eli Lilly's engineers were able to provide power so that production could begin just 90 days after the go-ahead.

watch for the June issue of INDUSTRY & POWER

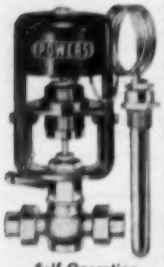
TEMPERATURE of cooling water system for 2-stage air compressor at CECO STEEL CORP. is controlled by 2 Powers Regulators



For Reliable Control of JACKET COOLING WATER In AIR COMPRESSORS Gas and Diesel Engines

Use POWERS REGULATORS

No. 11 REGULATOR



Self-Operating Easy to Install

They Improve the Efficiency and Prolong the Life of Air Compressors, Gas and Diesel Engines.

For each compressor or engine there is a "best" temperature for the cooling water. To insure that temperature at all times, regardless of variations in load or seasonal changes in temperature of water supply, install Powers No. 11 automatic regulators. They reduce operating and maintenance cost. Write for Cat. 329.

THE POWERS REGULATOR CO.
Skokie, Ill. • Offices in Chief Cities • (b54)

Over 60 Years of Automatic Temperature and Humidity Control

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This Super Tough Concrete Floor Patch

• SETS INSTANTLY
• WON'T 'STRIKE OUT'

Simply shovel INSTANT-USE into hole or rut — tamp smooth — truck over! No waiting! INSTANT-USE bonds tight to old concrete—right up to a feather edge. It's tough. Wears like iron. Won't crack or crumble. Install complete overlay where floors are badly chewed up. Used indoors or out. Immediate shipment.

Get FREE HANDBOOK and Trial Offer!

Mail Coupon for Trial Offer

INSTANT-USE

FLEXROCK CO. *Offices in Principal Cities*
3605 Filbert St., Philadelphia 1, Pa.

Please send complete INSTANT-USE information details of TRIAL ORDER PLAN, and HANDBOOK OF BUILDING MAINTENANCE—no obligation. (Clip and attach coupon to Company letterhead).

Name .....
Title .....
Company .....
Address .....

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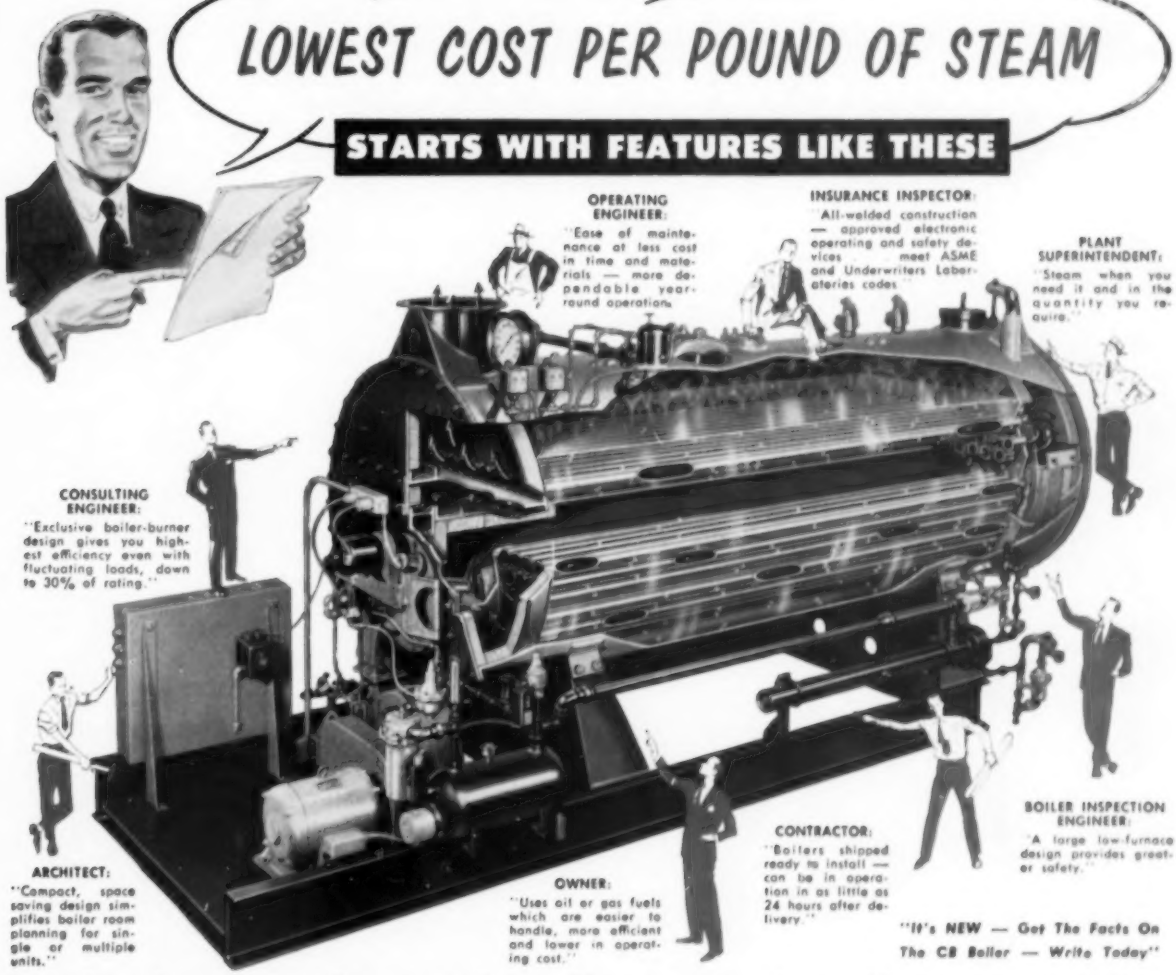
LOWEST COST PER POUND OF STEAM

STARTS WITH FEATURES LIKE THESE


OPERATING ENGINEER:
"Ease of maintenance at less cost in time and materials — more dependable year-round operation."
INSURANCE INSPECTOR:
"All-welded construction — approved electronic operating and safety devices — meet ASME and Underwriters Laboratories codes."
PLANT SUPERINTENDENT:
"Steam when you need it and in the quantity you require."
CONSULTING ENGINEER:
"Exclusive boiler-burner design gives you highest efficiency even with fluctuating loads, down to 30% of rating."
ARCHITECT:
"Compact, space saving design simplifies boiler room planning for single or multiple units."
OWNER:
"Uses oil or gas fuels which are easier to handle, more efficient and lower in operating cost."
CONTRACTOR:
"Boilers shipped ready to install — can be in operation in as little as 24 hours after delivery."
BOILER INSPECTION ENGINEER:
"A large low-furnace design provides greater safety."

"It's NEW — Get The Facts On The CB Boiler — Write Today"

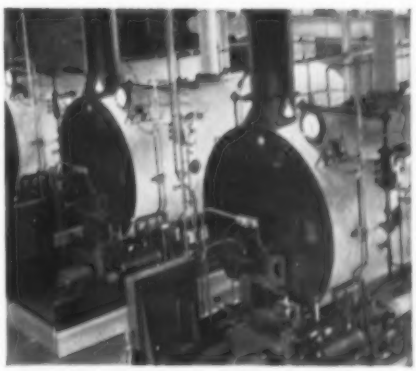
that's why you profit most from Cleaver-Brooks self-contained boilers

• Top to bottom, inside and out, you get more money-saving features when you specify or buy Cleaver-Brooks self-contained boilers. You make an *investment in quality* that pays off in lowest net cost per pound of steam for processing or heating.

YOU BENEFIT from more than 20 years of experience, working closely with men who have made it their business to be *right* about boilers. You profit from complete coordination throughout planning, installing, supervising and final operation.

YOU BENEFIT from self-contained design and original four-pass construction. These Cleaver-Brooks engineered "firsts," plus forced draft, 5 sq. ft. of heating surface per boiler hp, and exclusive burners, all contribute to highest heat transfer. Guaranteed 80% thermal efficiency when firing with oil is the direct result!

Whether you're planning a new steam plant or modernizing, make certain you get the complete Cleaver-Brooks story before you buy. See your Cleaver-Brooks representative, or write for catalog AD-137. Cleaver-Brooks Company, Dept. F, 303 East Keefe Avenue, Milwaukee 12, Wisconsin, U.S.A. *Cable Address CLEBRO — Milwaukee — All Codes.*



One typical owner can count on yearly savings ($15,000 fuel and $10,000 labor) from this battery of three 150 hp Cleaver-Brooks self-contained boilers.

•

NOW — FIRST SIZES OF THE CB BOILER ARE MADE IN CANADA, TOO.

•

Cleaver Brooks

ORIGINATORS OF THE SELF-CONTAINED BOILER

BOILERS . . . STEAM OR HOT WATER . . . FOR HEATING OR PROCESSING, IN SIZES FROM 15 TO 500 hp, 15 to 250 PSI.

Circle 556 on Reply Card for more data

"WE ENJOY REAL FUEL ECONOMY WITH TEXACO URSA OIL"

Elmer Leckrone, Plant Superintendent, Northwestern Public Service Company, Yankton, South Dakota

POWER PLANT of Northwestern Public Service Co., Yankton, S. D., has used *Texaco Ursa Oils* for 20 years. Fairbanks-Morse engines in service include three Model 33 slow-speed diesels, one Model 38 OP high-speed diesel, and one Model 31 AD 18 dual-fuel unit.

Northwestern Public Service Company's Yankton, S. D., plant operates both straight diesel and dual-fuel engines—all of them lubricated with *Texaco Ursa Oil*. Mr. Elmer Leckrone, Plant Superintendent, says:

"Never, in more than 20 years, has *Texaco Ursa Oil* 'let us down.' Our engines stay clean, wear is negligible, and we enjoy real fuel economy."

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